

Leach, Stacy

From: Nick Driban <ndriban@LENHARTTRAFFIC.COM>
Sent: Sunday, November 25, 2018 12:36 PM
To: Leach, Stacy
Cc: Conklin, Christopher; Bossi, Andrew; mlenhart
Subject: RE: Updated LATIP Study
Attachments: LATIP Memo Updated 20181112.pdf; Cut Through Memo 20181121.pdf

Stacy,

I've attached two traffic analysis memorandums that I would like to have entered into the Hillandale LATIP record. The two memos are as follows:

1. '*LATIP Memo Updated 20181112*' – This document provides an updated analysis on the LATIP improvements, based on the memorandum that was previously approved by the Maryland State Highway Administration (SHA) and Montgomery County Department of Transportation (MCDOT). It was submitted to Chris Conklin and Andrew Bossi at MCDOT in the week leading up to the hearing, so it may have already been entered into the record by them, but I'm submitting it directly to you in case it has not been. This is the most up-to-date assessment of the benefits of the proposed improvements package. The cover letter details the necessity of this update as well as changes from the analyses previously approved by SHA and MCDOT.
2. '*Cut Through Memo 20181121*' - This document was prepared as a response to concerns about cut-through traffic raised by the community prior to and during the hearing. As detailed in the document, while we believe the traffic calming measures already included along Elton Road as part of the slip ramp improvement will address the majority of community concerns, should the County elect to include additional changes to mitigate cut-through concerns we believe the recommendations in the attached memo are the optimal solution (to reduce cut-through traffic while maintaining the benefits at the intersection of MD 650 & Powder Mill Road).

Thanks,
Nick

Nick Driban, P.E., PTOE
Associate Vice President

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Lenhart Traffic Consulting, Inc.
Transportation Planning & Traffic Engineering

November 12, 2018

Ms. Stacy Leach
Montgomery County Department of Transportation
101 Monroe Street, 10th Floor
Rockville, Maryland 20850

Re: REVISED White Oak LATIP Supplemental Transportation Analysis – Proposed Improvements at MD 650 (New Hampshire Avenue) & Powder Mill Road/Elton Road

Dear Ms. Leach:

This letter is being prepared to provide an executive summary and additional context related to the attached memorandum detailing the *REVISED White Oak LATIP Supplemental Analysis – MD 650 & Powder Mill Road*. The attached memorandum represents the most recent revision to a series of analyses conducted in support of the improvements proposed in the Hillandale area as part of the White Oak LATIP. This revision is necessary in order to provide an updated assessment of the benefits of the proposed improvements package which is being considered in the Public Hearing scheduled for November 15, 2018. Included herein is a brief history of the LATIP analyses in this area and a summary of the findings of this current revision to the analyses.

On February 14, 2017, the Montgomery County Council passed the Local Area Transportation Improvement Program (LATIP) for the White Oak Science Gateway area. As part of Council approval, \$5,000,000 for work was assigned to the MD 650/Powder Mill Road intersection for traffic operations improvements, but specific improvements were not identified. At the time, specific improvements were not identified in this area because there were some anomalies noted in the original analysis conducted in support of the LATIP which resulted in recommendations that differed substantially from the White Oak Science Gateway Master Plan and from trip analyses previously conducted by the Maryland State Highway Administration (SHA).

The specific anomalies identified in the original LATIP analysis included the omission of a substantial volume of u-turning traffic along northbound MD 650 at Powder Mill Road, as well as the incorrect coding of volumes within the traffic model for the northbound through movement along MD 650 at Powder Mill Road. Based on the original analysis conducted with these anomalies, the recommended LATIP improvement at the intersection of MD 650 at Powder Mill Road was the addition of a northbound right-turn lane, which the original analysis showed would reduce the average delay at the intersection to less than 80 seconds (the threshold for acceptable operations for the area according to the LATIP). However, when the anomalies in the traffic analysis were corrected, the new analysis showed that the recommended addition of the northbound right-turn lane did not, in fact, improve average delay to less than 80 seconds at the intersection. Further, as noted in the discussion above, the northbound right-turn lane was not consistent with the proposed Master Plan improvements at the intersection.

Based on these findings, a supplemental analysis was conducted by Lenhart Traffic Consulting in the spring of 2017 in order to determine improvements that would reduce delay for the MD 650 at Powder Mill Road intersection to less than the 80 second threshold, thereby meeting the LATIP adequacy requirement. The starting point for addressing the identified traffic operations issue in the supplemental analysis was the consideration of the Master Planned improvements. The Master Plan improvements call for, “from Holly Hall, add an eastbound left-turn lane; on Powder Mill Road, add a

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westbound right-turn lane; and on MD 650, add a southbound left-turn lane.” The eastbound left-turn lane and westbound right-turn lane were included in the proposed improvement package in the supplemental analysis document, as construction of these improvements appeared to be feasible with limited impacts to the surrounding land uses. In contrast, the Master Plan recommended southbound left-turn lane was not included in the improvements package analysis as it was determined that its construction would be so materially impactful and require such significant takings of land (e.g. the properties to the northeast, northwest and southeast would all be significantly impacted including impacts to existing parking and structures) that this improvement would simply be too costly and infeasible in the short, intermediate, and likely long terms.

Traffic analysis was therefore conducted with the two, viable identified improvements along Powder Mill *only*, however the results showed that the intersection would not operate below the 80 second delay threshold without additional improvements. As such, and in order to address the unsafe u-turn traffic along northbound MD 650 at Powder Mill Road that was omitted from the original LATIP analysis, the slip-ramp from Elton Road was added to the two proposed improvements at the Powder Mill Road intersection. The reason for this improvement, as stated in the supplemental analysis, was to address the need to provide an alternate route to keep northbound u-turning traffic seeking to access the ramp to westbound I-495 (The Capital Beltway) away from the problematic intersection of MD 650 at Powder Mill Road in order to provide more ‘green time’ to the tremendous volume of vehicles traveling along MD 650. While other improvements at the intersection of MD 650 at Powder Mill Road were considered in lieu of the slip ramp, the close proximity of businesses along the northbound- and southbound approaches to the intersection simply left little room for any further improvement to take place directly at the intersection; stated differently, there are limited reasonable, feasible improvements at the intersection of MD 650 at Powder Mill Road beyond the Master Plan improvements along the eastbound- and westbound approaches to the intersection, which re included as part of the proposed package. The results of the supplemental analysis showed that with the improvements along eastbound and westbound Powder Mill Road, as well as the slip ramp, the intersection of MD 650 at Powder Mill Road would operate with delay below 80 seconds.

IT IS IMPORTANT TO NOTE that all supplemental analyses conducted prior to the version in the attached memo assumed that the only traffic reassigned to the Elton Road slip ramp was the northbound u-turning vehicles at the intersection of MD 650 at Powder Mill Road (shown on Exhibit 8a in the attached memo). The assumption to only reassign this volume was made in order to provide the most conservative analysis for agency review (SHA & MCDOT). Even with this highly conservative analysis, the improvements at the intersection of MD 650 at Powder Mill Road were shown to be so substantial (and with nearly no impact to the intersection of MD 650 at Elton Road) that both SHA and MCDOT concurred with the findings and recommendations of the analysis.

THE PURPOSE OF THE ATTACHED REVISED SUPPLEMENTAL ANALYSIS is to provide a more realistic analysis of the proposed improvements package. Specifically, it is likely that with the implementation of the Elton Road slip ramp, a substantial portion of the traffic that currently exits the north side of the shopping center located in the southeast corner of the MD 650 at Powder Mill Road intersection and turns left onto Powder Mill Road before turning left onto New Hampshire Avenue would instead exit the southside of the shopping center to turn right onto Elton Road and immediately access the new slip ramp (see Exhibit 8b in the attached memo). A traffic count was conducted to determine what proportion of the *total* left-turn volume from westbound Powder Mill Road onto MD

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650 is traffic that exits the north end of the shopping center and makes this movement in order to access the I-495 ramp. The results of this count indicated that approximately 20% of the *total* westbound left-turn volume from Powder Mill road onto New Hampshire Avenue comes from the shopping center. While it is believed that if given the opportunity the vast majority of this traffic would instead choose to exit the south side of the shopping center to utilize the Elton Road slip ramp, for the purposes of providing a conservative (but more reasonable analysis) it was assumed that 75% of the traffic making this movement would divert to the proposed slip ramp. This equates to a diversion of only 15% of the total westbound left-turns from Powder Mill Road onto New Hampshire Avenue ($75\% \times 20\% = 15\%$) and the resulting diverted volume is shown on Exhibit 8b of the attached memo (this analysis remains conservative in not accounting for any trips originating from within Hillandale currently exiting Green Forest Drive which could also utilize the ramp if given the opportunity).

Based on the assumptions documented above, as shown on Exhibit 9 of the attached memo the proposed improvements are projected to decrease delay for the intersection of MD 650 at Powder Mill Road by 40% in the AM peak hour and 45% in the PM peak hour compared to the No Build, with no measurable degradation in the level of service (LOS 'A') for the MD 650 at Elton Road intersection. THIS SIGNIFICANT IMPROVEMENT RESULTS *with no diversion assumed through the neighborhood*, but instead with traffic only diverted from the northbound u-turns and the shopping center traffic turning left onto Powder Mill Road and left onto MD 650 in order to access I-495 west. The proposed improvements package is also shown to decrease peak hour travel times along MD 650 by between 14% and 66%, and to substantially reduce delay to all vehicles in the area.

Importantly, the substantial improvements in traffic operations at the intersection of MD 650 at Powder Mill Road, as well as for vehicles along MD 650 and within the overall study area are likely to negate some amount of the cut-through traffic that has been a perennial concern to neighbors along Elton Road and Wooded Way. As traffic moves more freely along the major roadways and through the larger intersections designed to handle it, the incentive to find alternate routes through local streets is decreased. To the degree cut-through traffic is an existing issue for the neighborhood, traffic calming remedies are included as part of the proposed improvements package which have the ability to further reduce the desirability of this maneuver, thereby mitigating cut-through traffic.

Based on the findings of the attached *REVISED White Oak LATIP Supplemental Analysis – MD 650 & Powder Mill Road*, as well as the information contained in this letter, it is recommended that the proposed improvements included in the attached memo be approved and carried forward for design and construction as part of the White Oak LATIP.

Sincerely,



Michael Lenhart, P.E., PTOE
President

Enclosure: REVISED White Oak LATIP Supplemental Analysis – MD 650 & Powder Mill Road

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Memorandum:

Date: **November 12, 2018**

TO: Mr. Chris Conklin
 Montgomery County DOT
 101 Monroe Street, #10
 Rockville, MD 20850

FROM: Mike Lenhart

RE: REVISED White Oak LATIP Supplemental Analysis – MD 650 & Powder Mill Road

As part of this analysis, two scenarios were evaluated including:

- Total Conditions with no improvements (No Build) to intersection geometry and timings.
- Total Conditions with the following improvements:
 1. An additional EB left-turn lane (including modifications to existing lane use) and WB right-turn lane at the intersection of MD 650 & Powder Mill Road. Note that a dedicated WB right-turn lane at the intersection of MD 650 & Powder Mill Road is present under Existing Conditions, however, the westbound right turn lane is only 50' long. This is far shorter than a typical turn lane and is completely unusable because access to the right turn lane is blocked by queues in the adjacent lanes. Therefore, this 50' lane was not treated as a right turn lane in the analysis of existing geometrics.
 2. A slip ramp at the intersection of MD 650 & Elton Road to provide direct access from Elton Road to I-495 WB.
 3. Traffic calming along Elton Road in order to reduce speeds and enhance safety.

The following intersections were analyzed as part of this analysis including:

1. MD 650 & Powder Mill Road
2. MD 650 & Elton Road

In addition to this memo, the following exhibits and appendices have been included:

- Exhibit 1 Presents a location map and shows the study intersections.
- Exhibit 2 Provides the existing lane use and traffic controls devices.
- Exhibit 3 Includes the existing peak hour traffic volumes at the intersections. Note that these counts were taken from SHA's ITMS website, and are the same counts used in the LATIP analysis. It should be noted however that the LATIP analysis had two errors in their existing traffic counts. The LATIP study failed to include northbound and southbound MD 650 U-turns, and had an incorrect through volume for northbound MD 650 in the morning peak hour.



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- Exhibit 4 Provides the 2040 background peak hour traffic volumes which were taken from the White Oak LATIP with the exception of the background growth in traffic on the west leg of MD 650 at Powder Mill Road in and out of the Holly Hall apartments. The growth in traffic on the west leg is calculated in Exhibits 5 and 6 as follows.
- Exhibit 5 Contains the trip generation table for the Hillandale Gateway development. While the 2040 peak hour volumes from the White Oak LATIP generally accounted for traffic from planned developments in the area, in order to be conservative, trip generation and assignment were conducted separately for the Hillandale Gateway development as part of this study due to its immediate proximity to the study intersections and because it is one of the first sites planned for development in the White Oak LATIP area. Note that a trip credit was assumed for the existing 96 senior adult dwelling units. The proposed development is understood to consist of 146 senior adult dwelling units, 350 apartment units, and 24,500 square feet of shopping center.
- Exhibit 6a-c Exhibits 6a-6c detail the residential, retail, and pass-by trip assignments for the planned Hillandale Gateway development. The trip assignment is based on the net increase in trips over and above the existing use. It should be noted that a right-in/right-out driveway is planned for the site in addition to the access from the west leg of the MD 650 & Powder Mill Road intersection.
- Exhibit 7 Combines the 2040 background peak hour traffic volumes shown on Exhibit 4 with the trip assignments shown on Exhibits 6a-6c to provide total traffic volumes.
- Exhibits 8a-b Shows the assumed traffic diversions as a result of the construction of a slip ramp which would provide direct access from Elton Road to I-495 WB.
- Exhibit 8c Combines the total traffic volumes shown on Exhibit 7 with the traffic diversions shown on Exhibits 8a-b to provide total peak hour volumes with diversions. Note that these volumes were used in the "Total with Improvements" scenario.
- Exhibit 9 Provides a table showing Level of Service using the HCS methodology at the two study intersections. The LATIP uses an 80 second threshold for the determination of intersection adequacy. In addition, the table provides overall corridor measures of effectiveness including travel time along MD 650 between the Capital Beltway and north of Powder Mill Road, as well as the total delay experienced by all vehicles traveling in the area (based on the study area included within the traffic model).
- Exhibit 10 Shows the proposed lane use and traffic control devices under the "Total with Improvements" scenario.
- Appendix A Provides supplemental information and turning movement counts.
- Appendix B Provides the Synchro/SimTraffic worksheets.
- Appendix C Includes concept design plans for the proposed improvements.



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The following information is a summary of the results of our analyses:

- Under Total Conditions without any improvements (No Build) to intersection geometry or timing, the signalized study intersection of MD 650 & Powder Mill Road will operate with an overall intersection delay of **greater than 80 seconds during the PM peak hour** (76.9 seconds and 125.0 seconds during the AM and PM peak hours respectively). As mentioned previously, the LATIP uses an 80 second threshold for the determination of intersection adequacy. Therefore, intersection improvements are required in order to meet the LATIP guidelines.
- The “Total with Improvements” scenario includes a portion of the Master Plan improvements (EB Left + WB Right at MD 650 & Powder Mill Road) and a slip ramp at the intersection of MD 650 & Elton Road to provide direct access from Elton Road to I-495 WB. Under this scenario, the signalized study intersection of MD 650 & Powder Mill Road will operate with an overall intersection delay of **less than 80 seconds** (46.0 seconds and 69.0 seconds during the AM and PM peak hours respectively) which satisfies the LATIP requirements. In addition, the intersection of MD 650 & Elton Road will operate with 10 seconds of delay or less during both the AM and PM peak hours.
- It should also be noted that the MD 650 Corridor will experience overall travel time improvements ranging from 14% to 66% depending on the direction of travel and peak hour. Furthermore, the total delay for all vehicles traveling in the area will be reduced by 38% in the AM peak hour and 14% in the PM peak hour with the proposed improvements.

Based on the results of this analysis, all signalized study intersections under the “Total with Improvements” scenario will operate with less than 80 seconds of delay and will satisfy LATIP requirements. If you have any questions regarding this matter, please do not hesitate to contact me at the number below. We look forward to your feedback and guidance in how you would like to proceed.

Thanks,
Mike



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Study Intersections:
1. MD 650 & Powder Mill Road
2. MD 650 & Elton Road

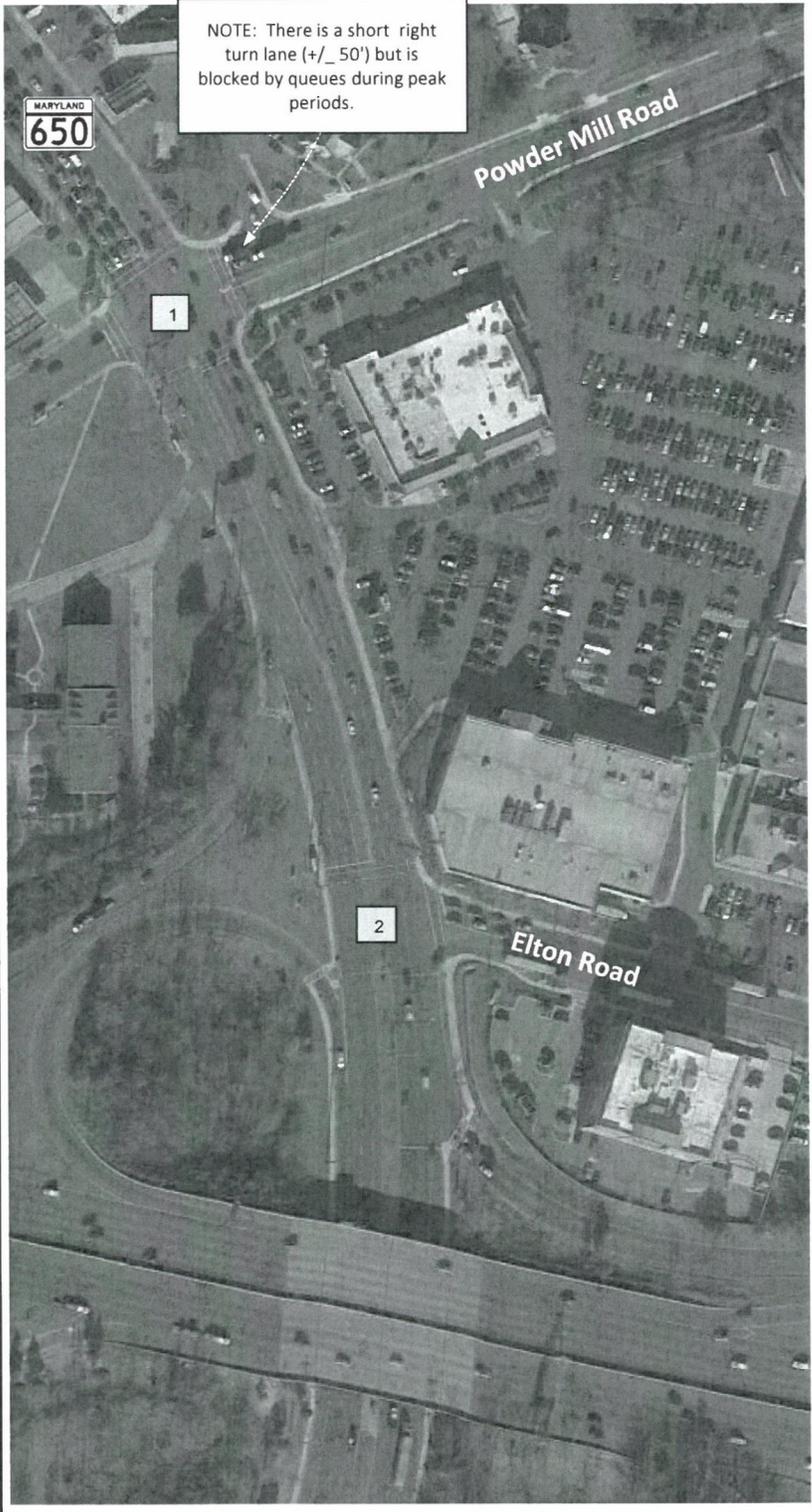
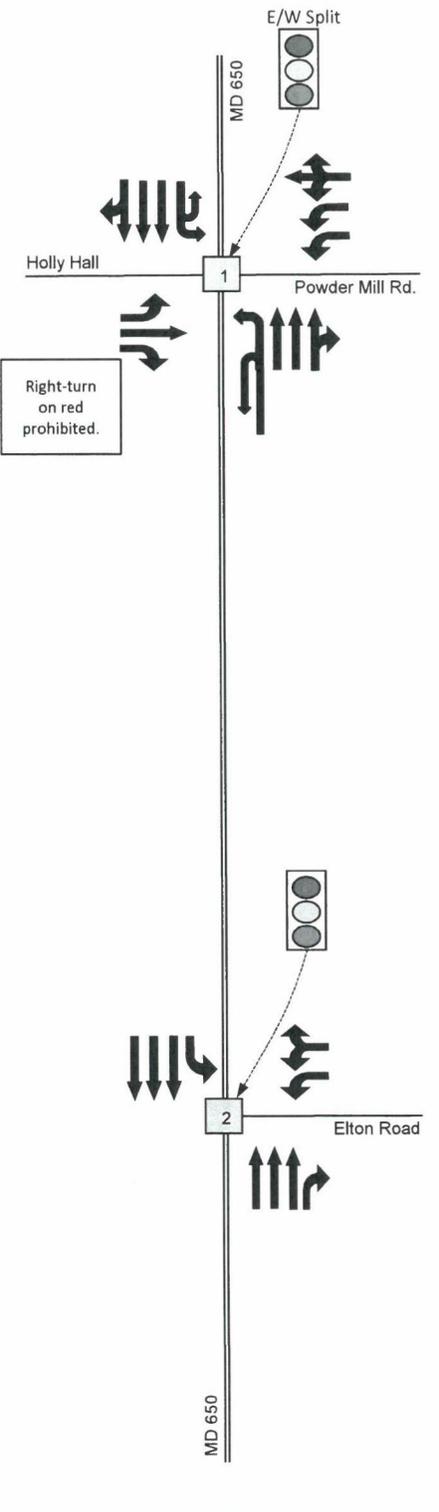


White Oak L.A.TIP Analysis

Location
Map

Exhibit
1

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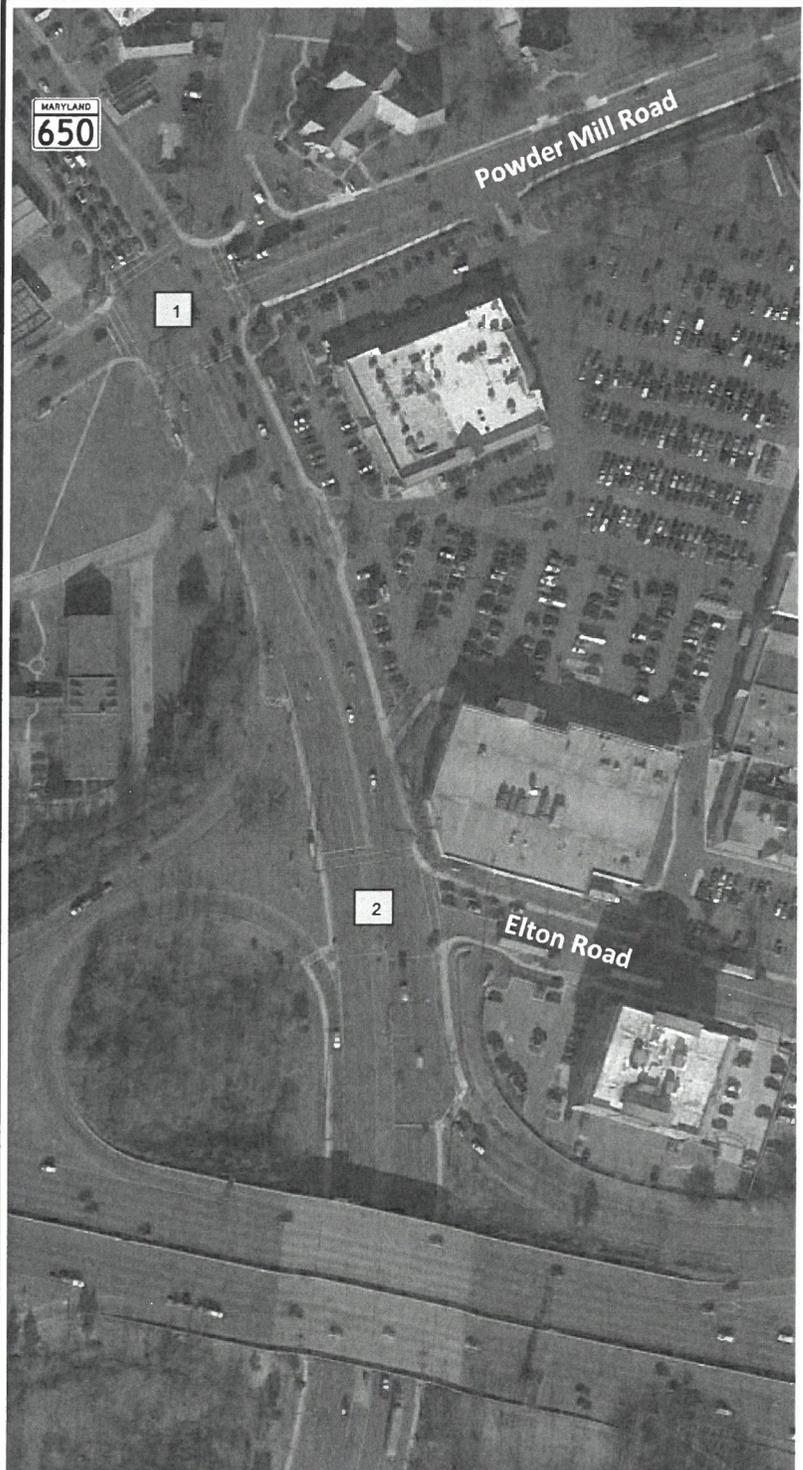
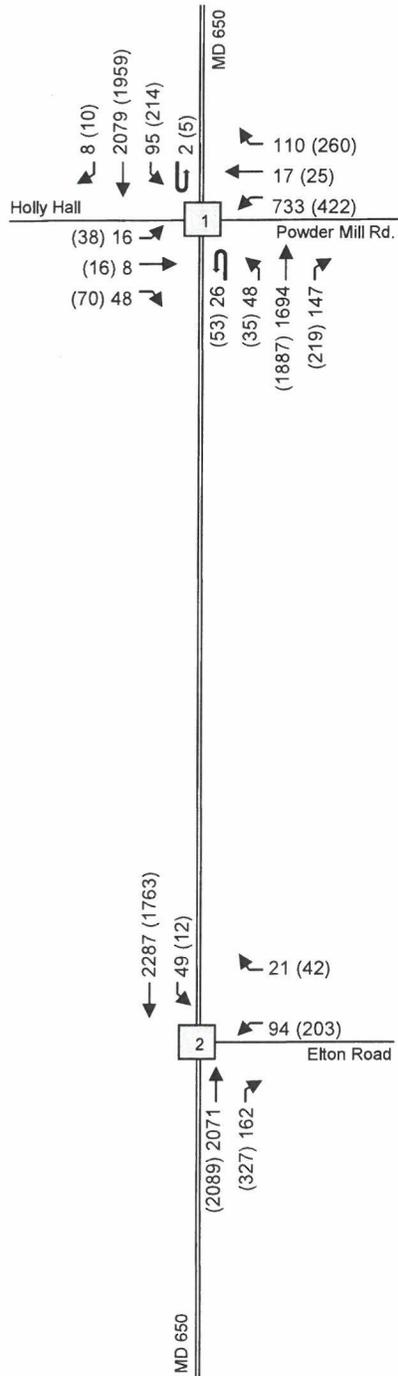


White Oak LATIP Analysis

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Existing Lane Use &
 Traffic Control Devices

Exhibit
2



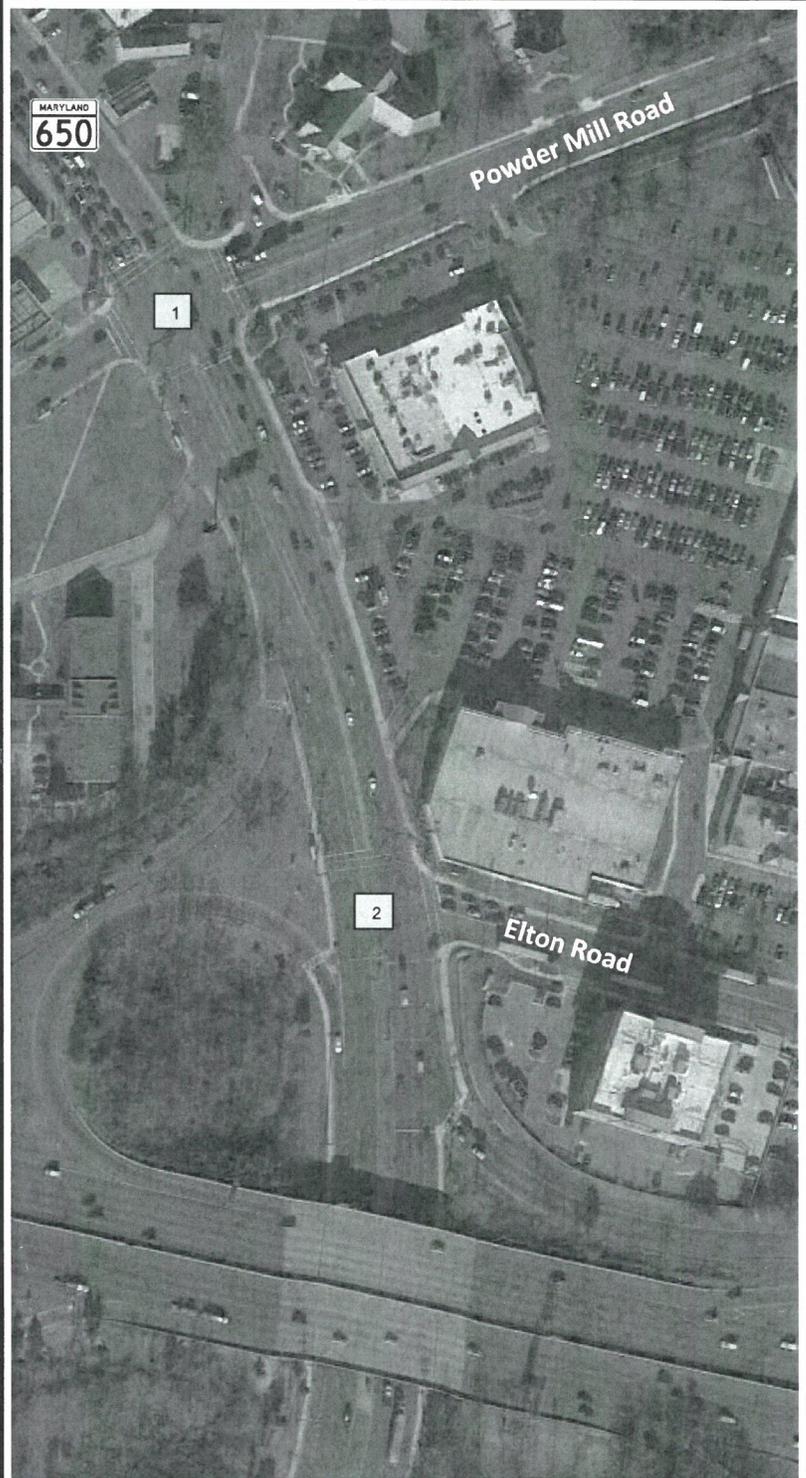
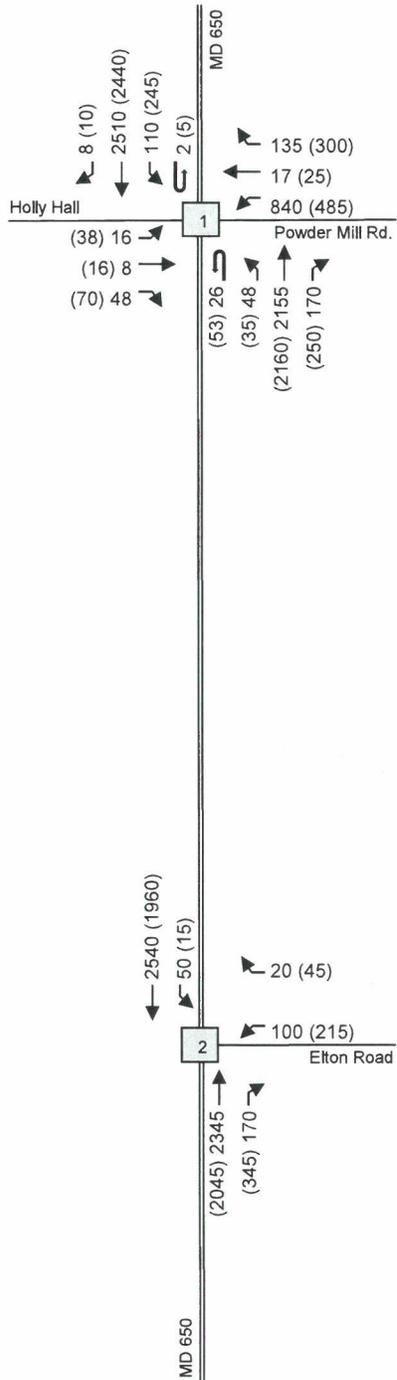
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Existing
 Peak Hour Volumes

Key: xx = AM Peak Vol's (xx) = PM Peak Vol's

Exhibit
 3



White Oak LATIP Analysis

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2040 Background
 Peak Hour Volumes

Key: xx = AM Peak Vol's (xx) = PM Peak Vol's

Exhibit
4

Trip Generator Rates

<p>Apartment Units (ITE-220, Units)</p> <p>Morning Trips = 0.51 x Units</p> <p>Evening Trips = 0.62 x Units</p> <p>Daily Trips = 6.65 x Units</p> <p>Senior Adult Housing - Attached (ITE-252, Units)</p> <p>Morning Trips = 0.20 x Units</p> <p>Evening Trips = 0.25 x Units</p> <p>Daily Trips = 3.44 x Units</p> <p>Shopping Center (ksf, ITE-820)</p> <p>Morning Trips = 0.96 x ksf</p> <p>Evening Trips = 3.71 x ksf</p> <p>Daily Trips = 42.70 x ksf</p>	<p><u>Trip Distribution (In/Out)</u></p> <p>20/80</p> <p>65/35</p> <p>50/50</p> <p><u>Trip Distribution (In/Out)</u></p> <p>34/66</p> <p>54/46</p> <p>50/50</p> <p><u>Trip Distribution (In/Out)</u></p> <p>62/38</p> <p>48/52</p> <p>50/50</p>
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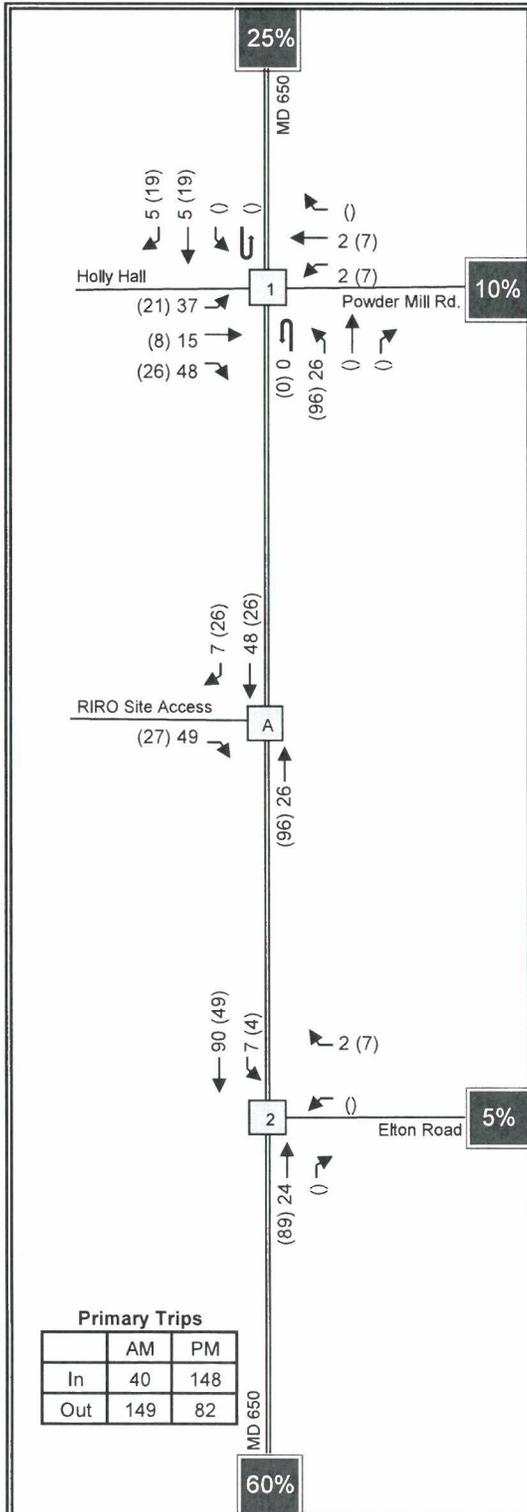
Trip Generator Totals

			AM Peak			PM Peak			Daily
			In	Out	Total	In	Out	Total	Total
Existing	Senior Adult Housing - Attached (ITE-252, Units)	96 units	6	13	19	13	11	24	330
Proposed	Senior Adult Housing - Attached (ITE-252, Units)	146 units	10	19	29	20	17	37	502
Proposed	Apartment Units (ITE-220, Units)	350 units	36	143	179	141	76	217	2328
Total New Residential Primary Trips			40	149	189	148	82	230	2500
Proposed	Shopping Center (ksf, ITE-820)	24,500 SF	15	9	24	44	47	91	1046
Shopping Center Pass-by (0% AM/34% PM)			0	0	0	-15	-16	-31	-356
Total New Retail Primary Trips			15	9	24	29	31	60	690

Notes:

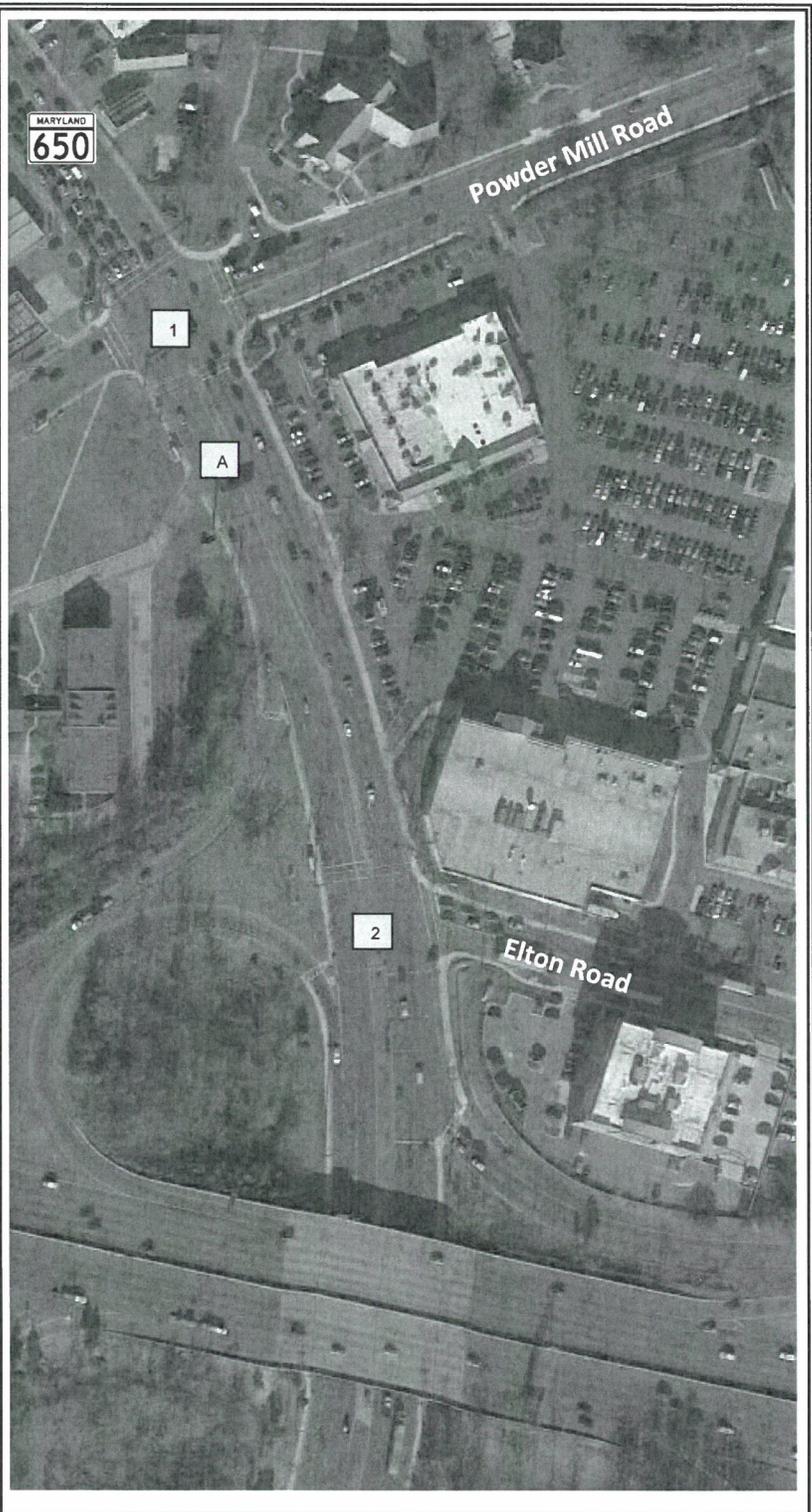
1. Trip Generation Rates obtained from the ITE Trip Generation Manual, 9th Edition

White Oak LATIP Analysis	Trip Generation for Hillandale Development	Exhibit 5
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Primary Trips

	AM	PM
In	40	148
Out	149	82



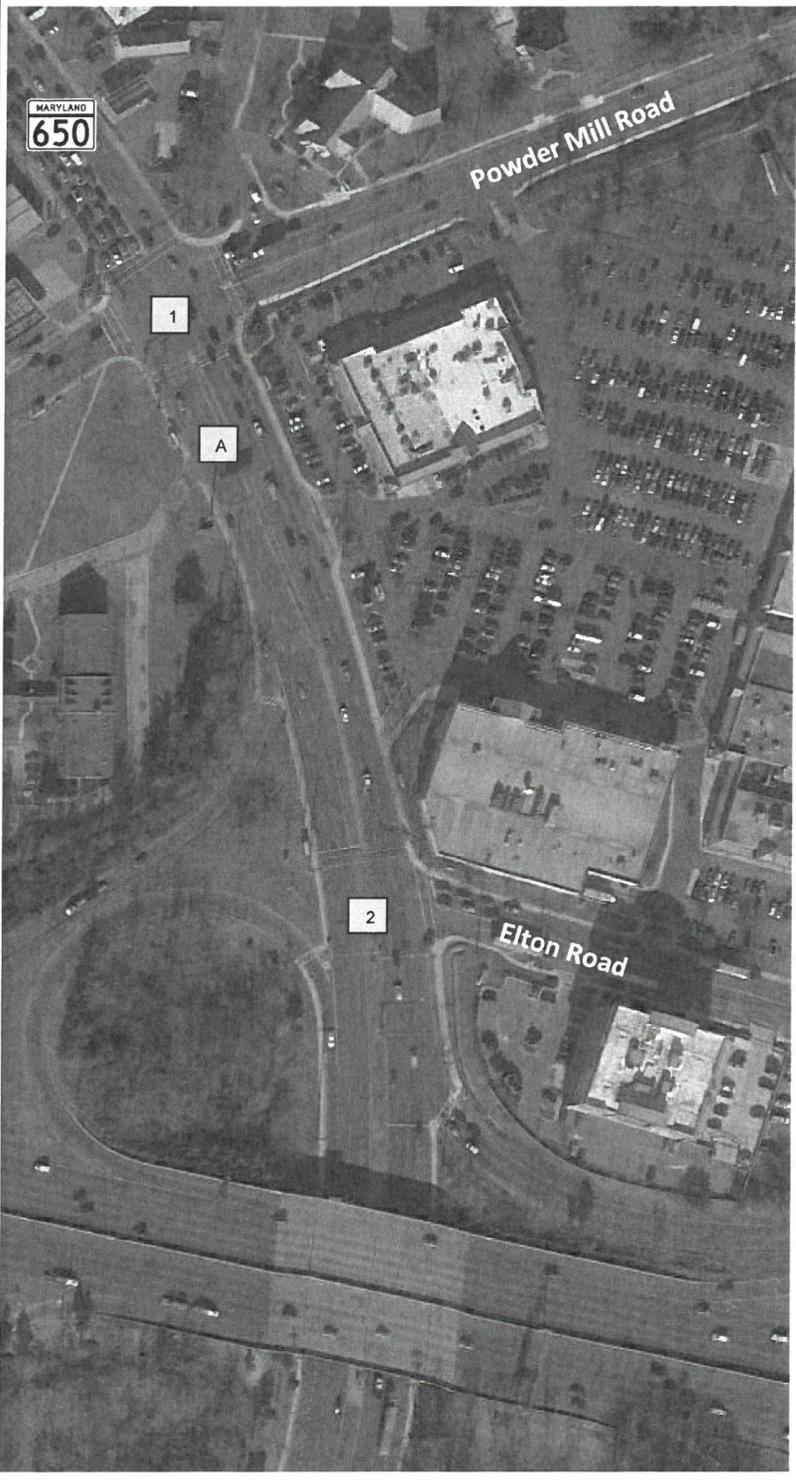
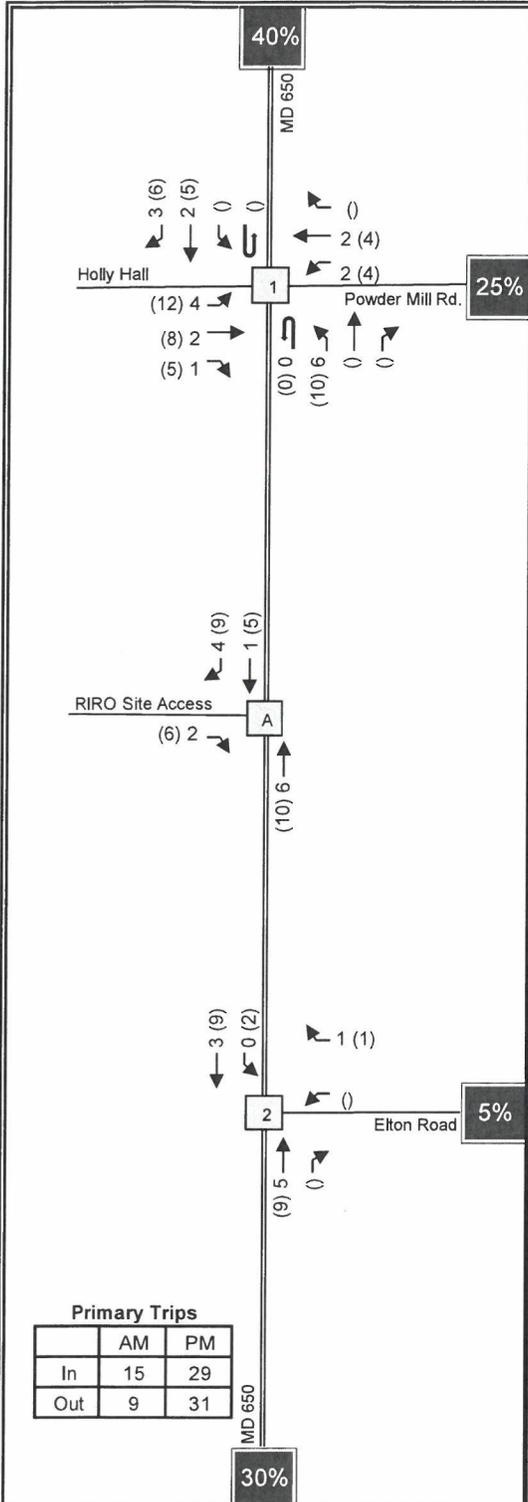
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Trip Assignment for Hillandale (Residential)

Key: xx = AM Peak Vol's (xx) = PM Peak Vol's

Exhibit 6a



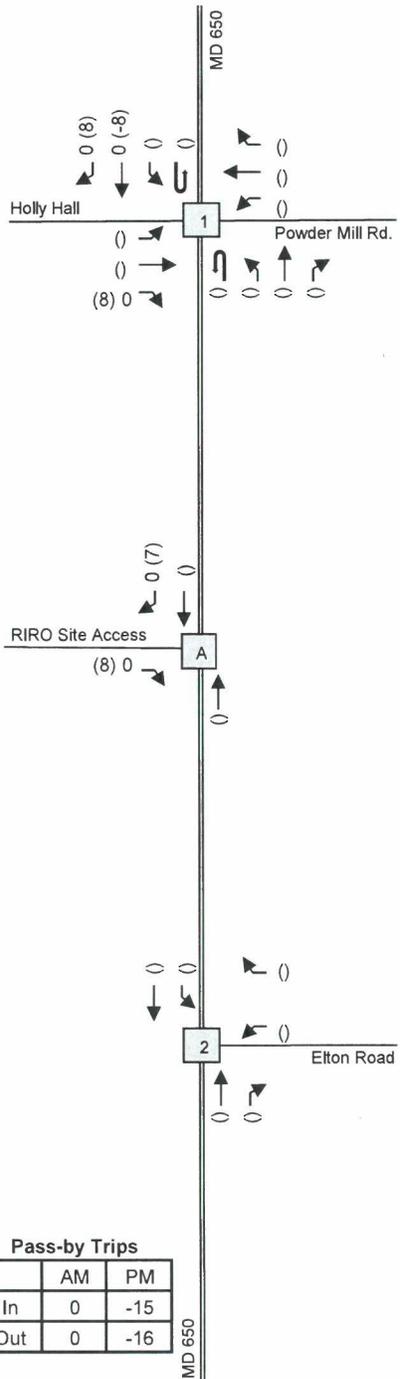
White Oak LATIP Analysis

Trip Assignment for Hillandale (Shopping Center)

Exhibit 6b

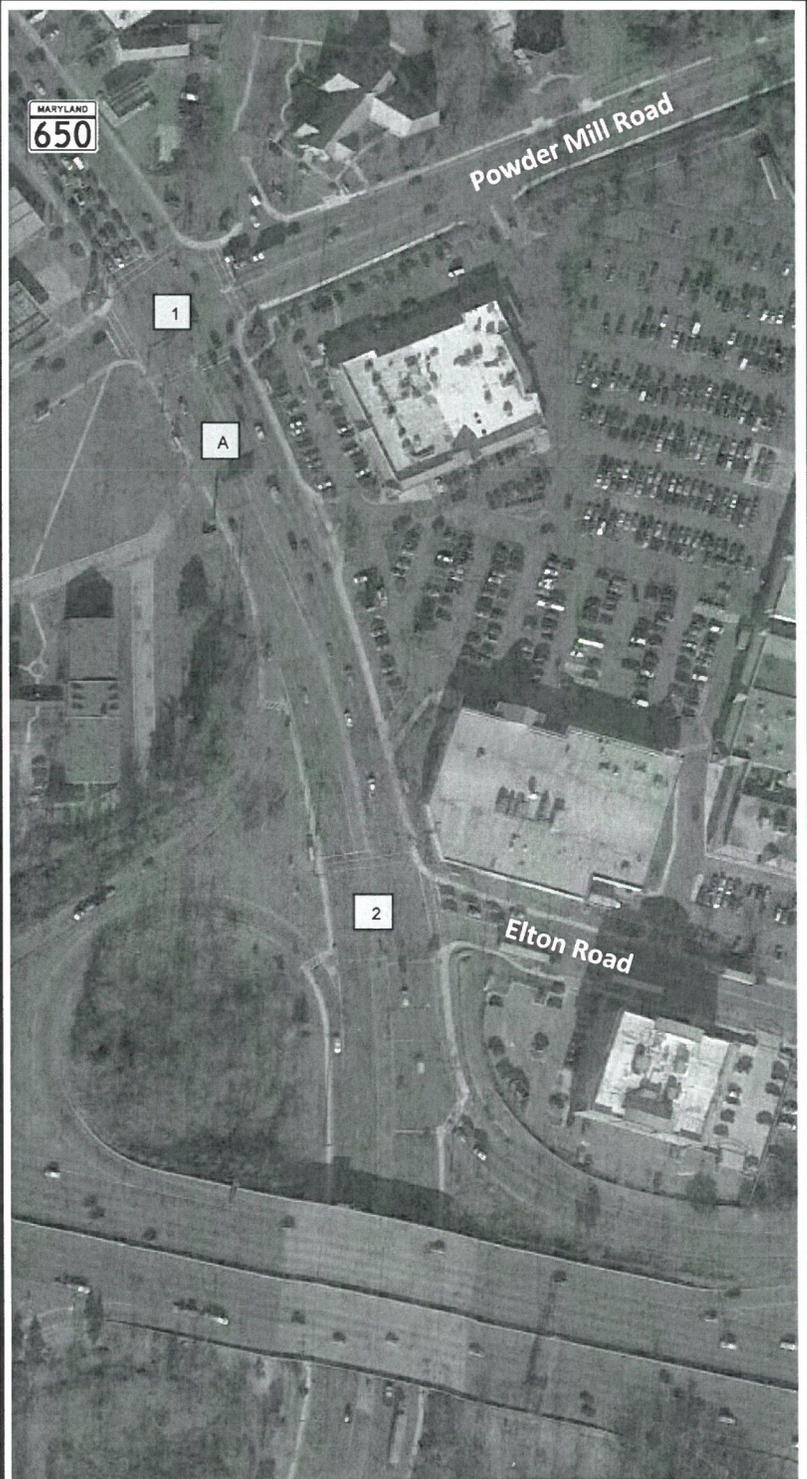
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Key: xx = AM Peak Vol's (xx) = PM Peak Vol's



Pass-by Trips

	AM	PM
In	0	-15
Out	0	-16



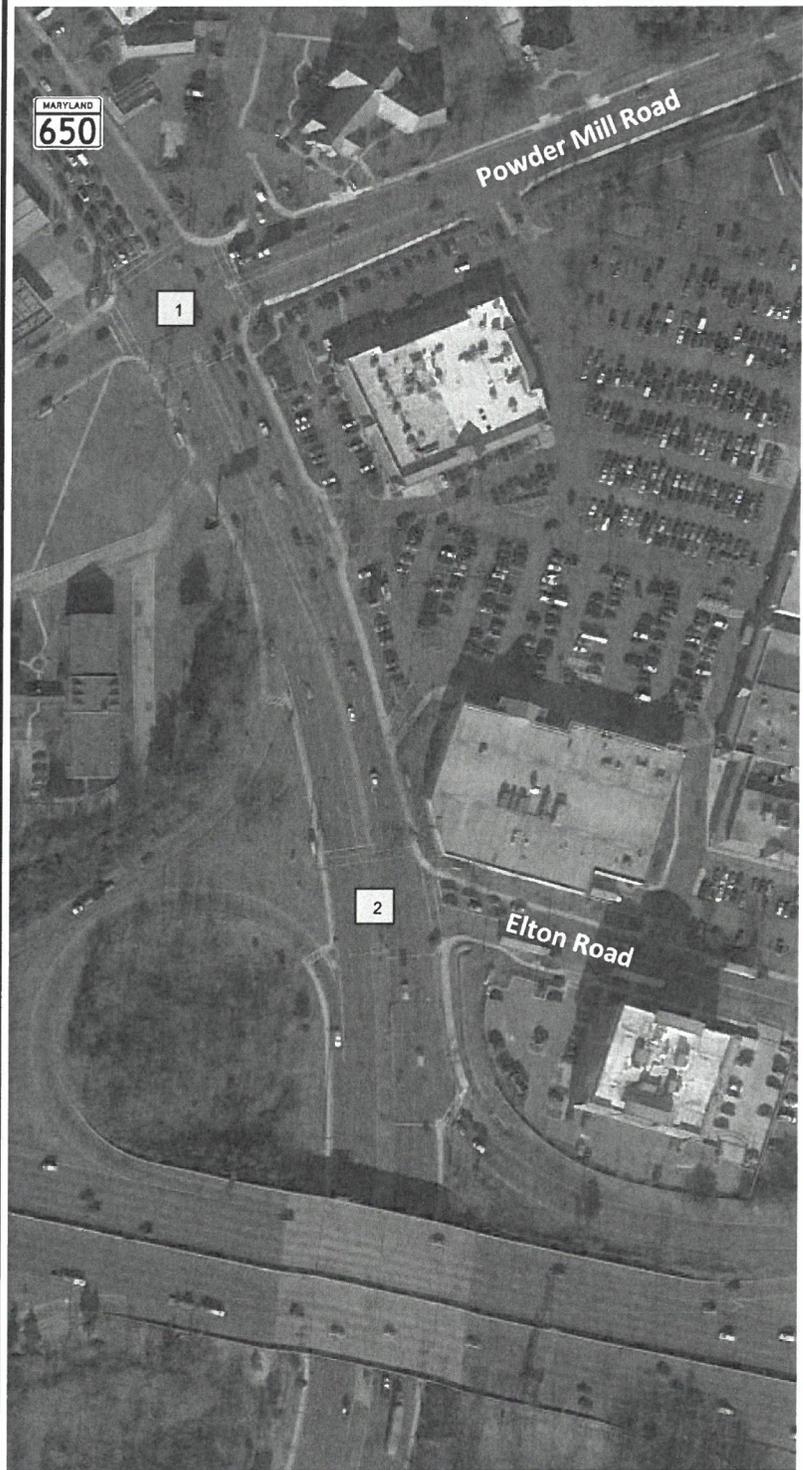
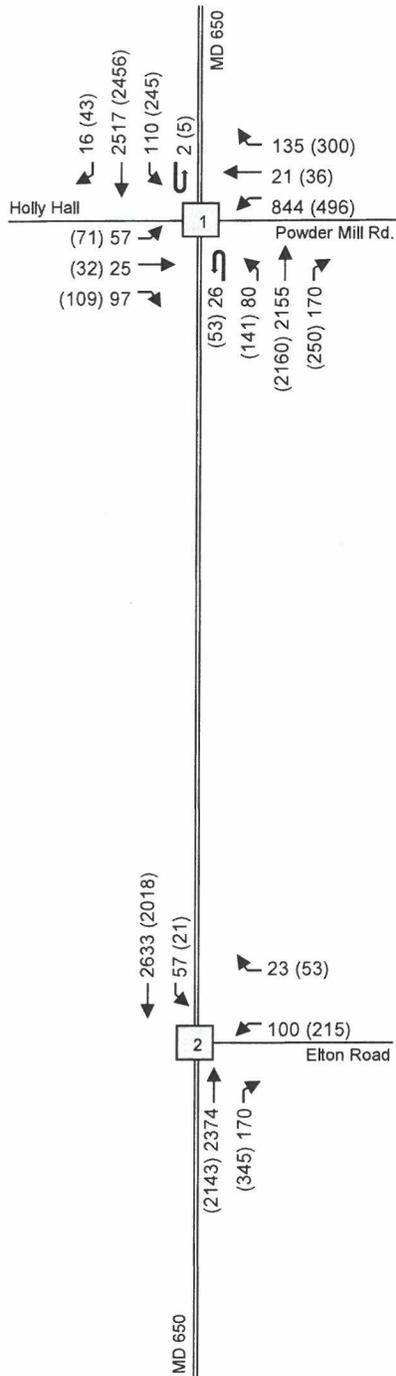
White Oak LATIP Analysis

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Pass-by Trip for Hillandale
 (Shopping Center)

Exhibit
 6c

Key: xx = AM Peak Vol's (xx) = PM Peak Vol's



White Oak LATIP Analysis

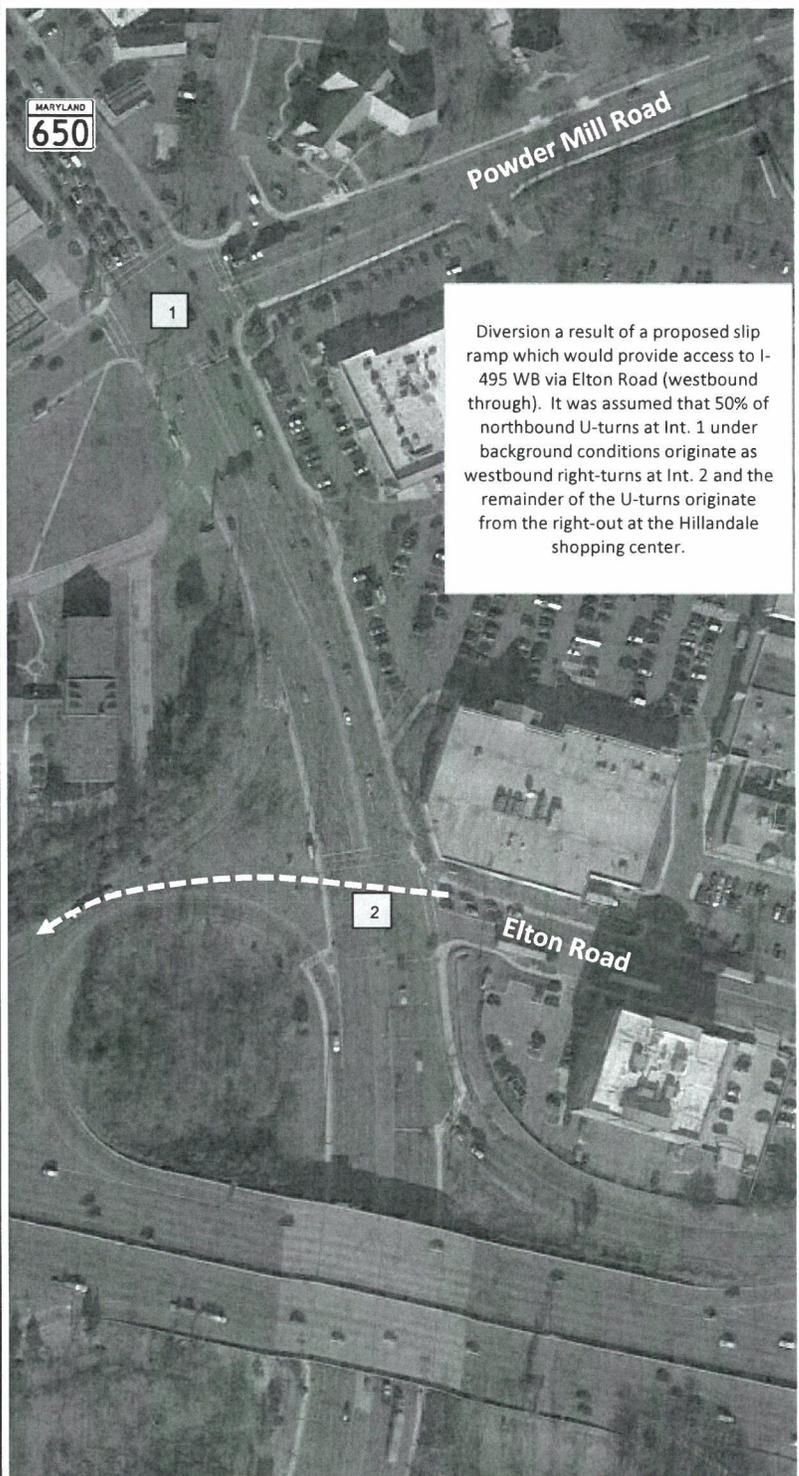
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Total
 Peak Hour Volumes

Key: xx = AM Peak Vol's (xx) = PM Peak Vol's

Exhibit

7



Diversion a result of a proposed slip ramp which would provide access to I-495 WB via Elton Road (westbound through). It was assumed that 50% of northbound U-turns at Int. 1 under background conditions originate as westbound right-turns at Int. 2 and the remainder of the U-turns originate from the right-out at the Hillandale shopping center.

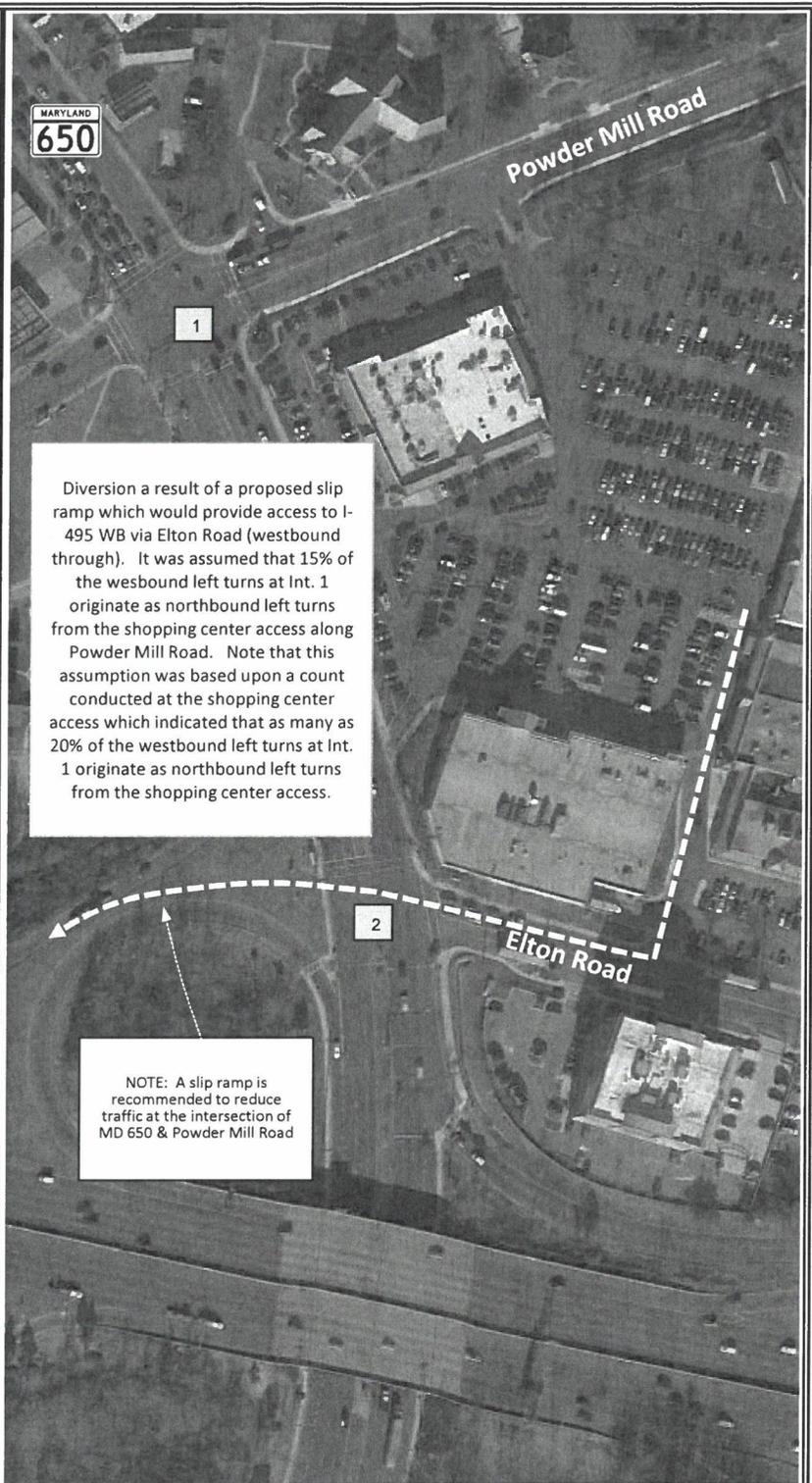
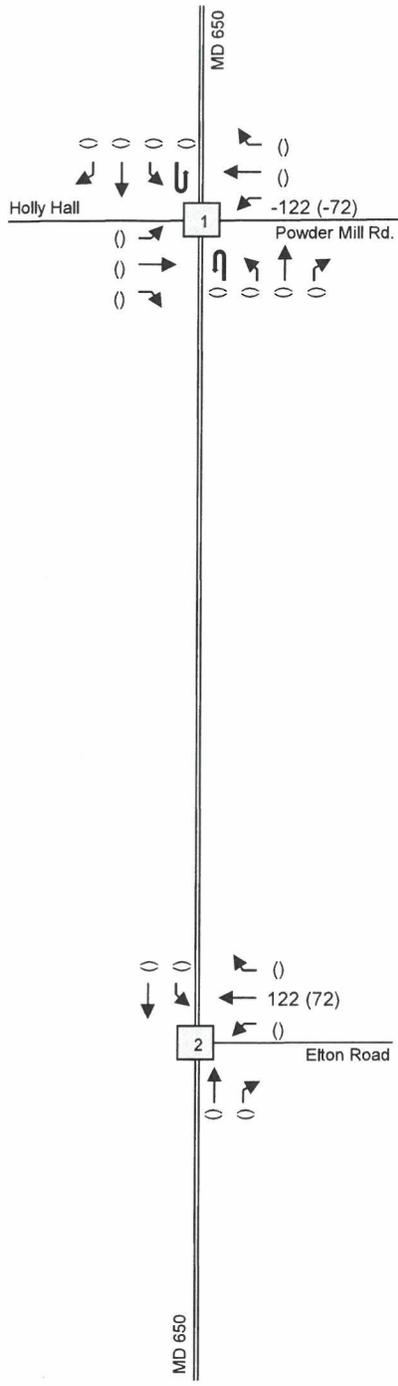
White Oak LATIP Analysis

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Potential Diversion at Intersection 1
 (Northbound U-Turn)

Key: xx = AM Peak Vol's (xx) = PM Peak Vol's

Exhibit
8a



Diversion a result of a proposed slip ramp which would provide access to I-495 WB via Elton Road (westbound through). It was assumed that 15% of the westbound left turns at Int. 1 originate as northbound left turns from the shopping center access along Powder Mill Road. Note that this assumption was based upon a count conducted at the shopping center access which indicated that as many as 20% of the westbound left turns at Int. 1 originate as northbound left turns from the shopping center access.

NOTE: A slip ramp is recommended to reduce traffic at the intersection of MD 650 & Powder Mill Road

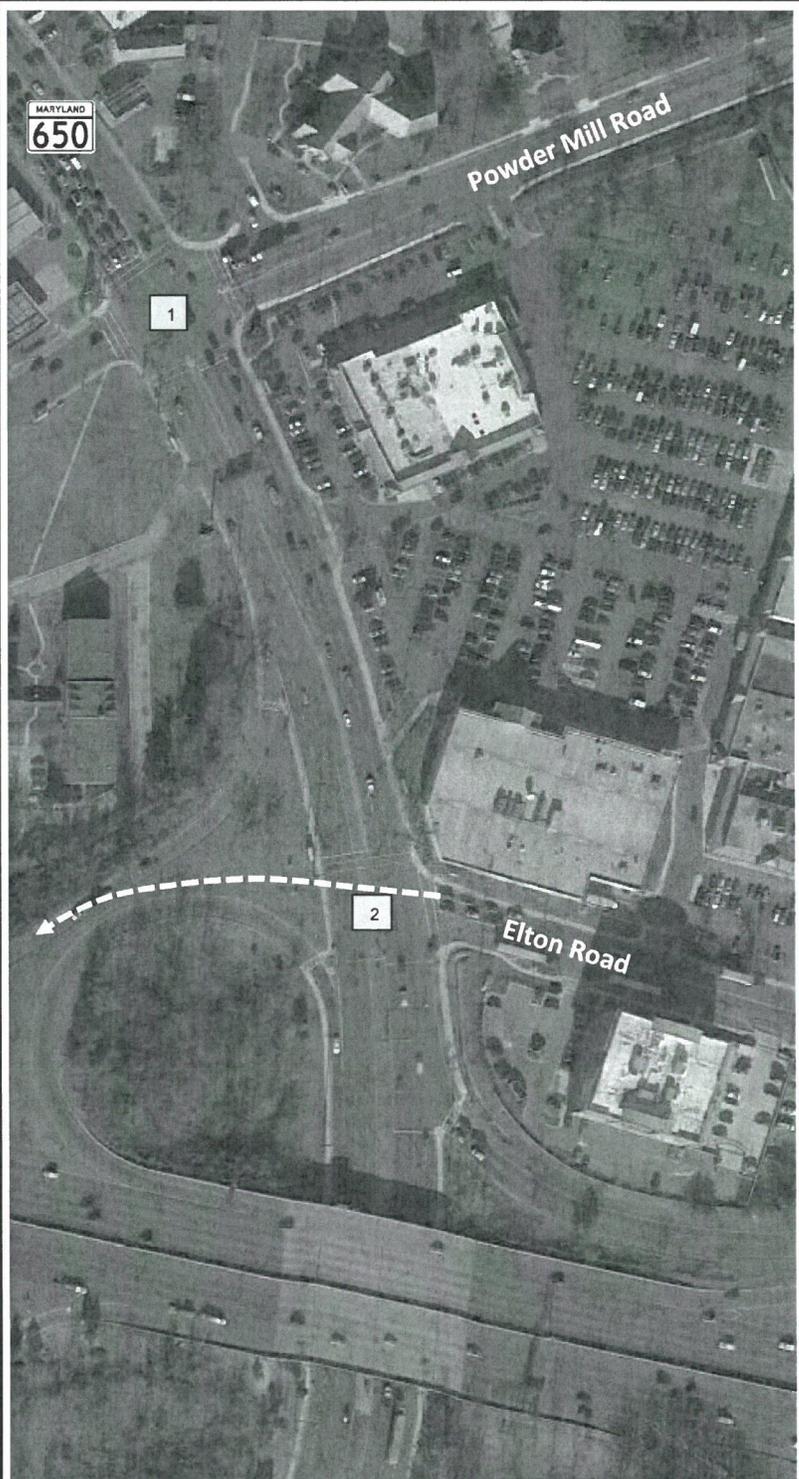
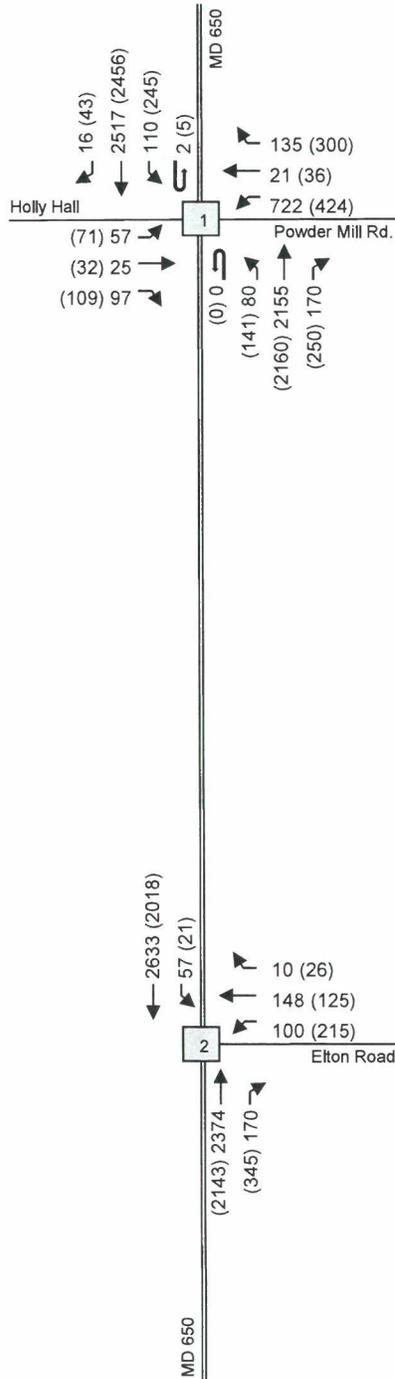
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Potential Diversion at Intersection 1
 (Westbound Left-Turn)

Key: xx = AM Peak Vol's (xx) = PM Peak Vol's

**Exhibit
 8b**



White Oak LATIP Analysis

Total Peak Hour Volumes with Diversions

**Exhibit
8c**

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Key: xx = AM Peak Vol's (xx) = PM Peak Vol's

2040 Traffic Operations Summary

Intersection Operations

(Level of Service / Average Delay per Vehicle in Seconds)

Morning Peak Hour	No Build	With Improvements
1). MD 650 & Powder Mill Road <i>Percent Improvement compared to No Build</i>	E / 76.9 ---	D / 46.0 40%
2). MD 650 & Elton Road	A / 4.8	A / 10.0
Evening Peak Hour	No Build	With Improvements
1). MD 650 & Powder Mill Road <i>Percent Improvement compared to No Build</i>	F / 125.0 ---	E / 69.0 45%
2). MD 650 & Elton Road	A / 9.6	A / 9.1

- Notes:
1. Results shown in the following format: Level of Service / Average Delay per Vehicle in Seconds
 2. The Average Delay per Vehicle in Seconds is the average delay experienced by each and every vehicle passing through the intersection, i.e. an average delay of 60.0 seconds indicates that it takes every vehicle, on average, one minute to get through the intersection, regardless of which direction the vehicle is traveling.
 3. All results are from Synchro/SimTraffic, a traffic analysis and microsimulation software package.

Corridor Measures of Effectiveness

Morning Peak Hour	No Build	With Improvements
MD 650 Travel Time (See Note 1, below) <i>Northbound</i> <i>Percent Improvement compared to No Build</i>	151 secs. ---	124 secs. 18%
<i>Southbound</i> <i>Percent Improvement compared to No Build</i>	504 secs. ---	170 secs. 66%
Total Network Delay (See Note 2, below) <i>Percent Improvement compared to No Build</i>	593 hours ---	369 hours 38%
Evening Peak Hour	No Build	With Improvements
MD 650 Travel Time (See Note 1, below) <i>Northbound</i> <i>Percent Improvement compared to No Build</i>	634 secs. ---	546 secs. 14%
<i>Southbound</i> <i>Percent Improvement compared to No Build</i>	583 secs. ---	413 secs. 29%
Total Network Delay (See Note 2, below) <i>Percent Improvement compared to No Build</i>	600 hours ---	514 hours 14%

- Notes:
1. Average travel time in seconds from Capital Beltway to north of Powder Mill Road. This is a measure of how effectively traffic is moving along MD 650.
 2. Total Network Delay = Number of Vehicles x Average Delay per Vehicle within the traffic model, which extends along MD 650 from Oakview Drive to Chalmers Road. It is a measure of how the overall transportation system is performing in this area.
 3. All results are from Synchro/SimTraffic, a traffic analysis and microsimulation software package.

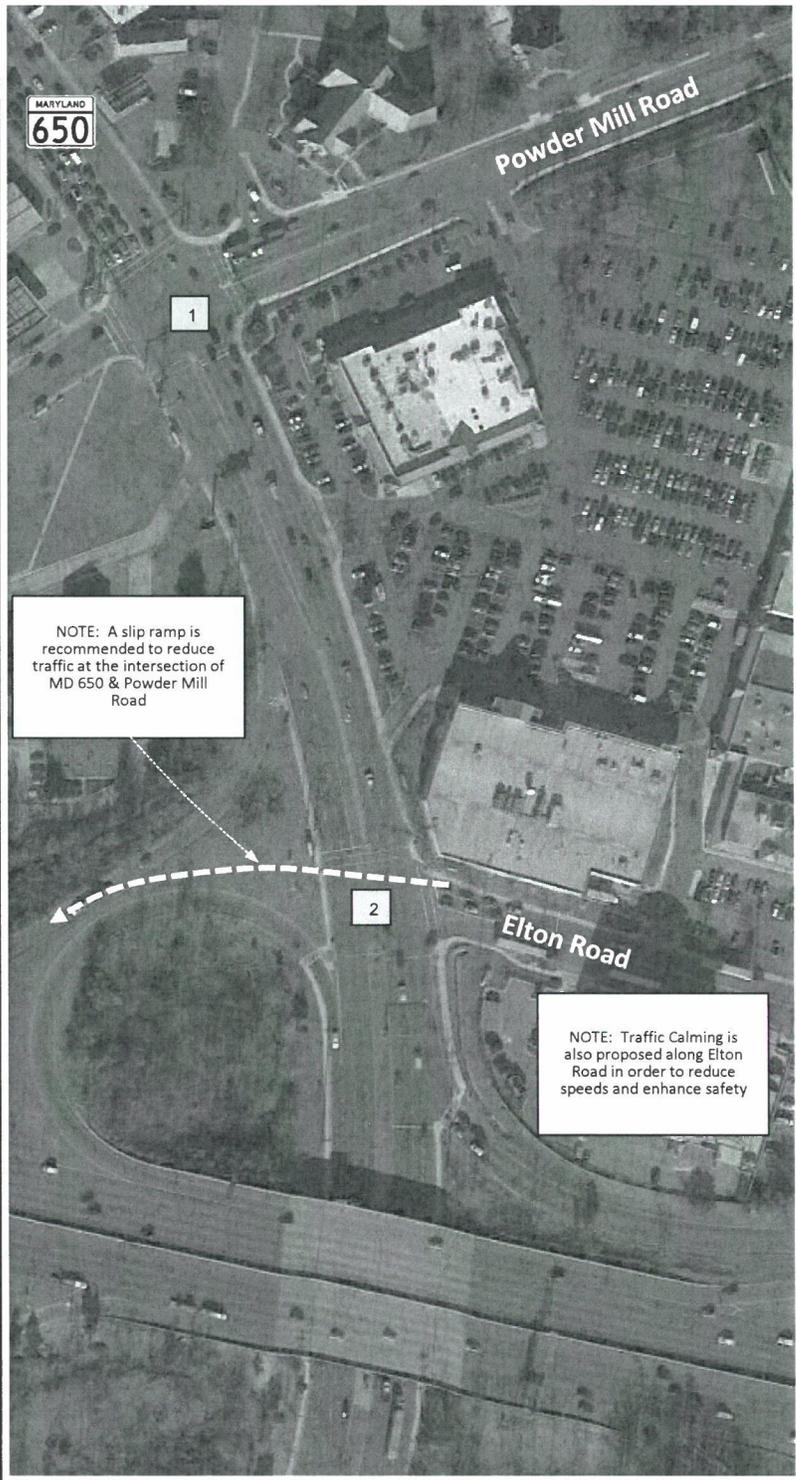
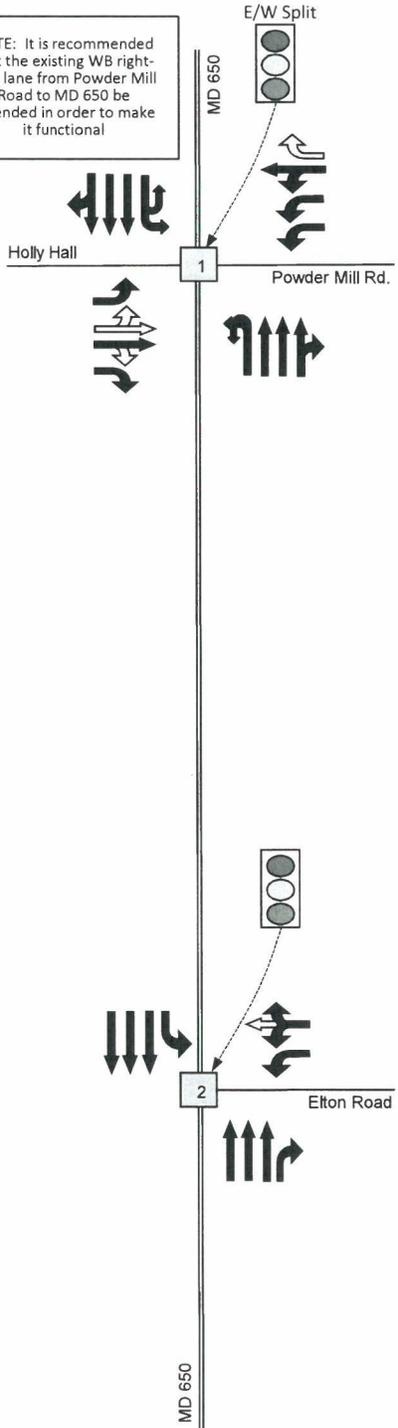
White Oak LATIP Analysis

Results of Traffic
Operations Analyses

**Exhibit
9**

LENHART TRAFFIC CONSULTING, INC.
645 BALTIMORE ANNAPOLIS BLVD, SUITE 214
SEVERNA PARK, MD 21146
www.lenharttraffic.com

NOTE: It is recommended that the existing WB right-turn lane from Powder Mill Road to MD 650 be extended in order to make it functional



NOTE: A slip ramp is recommended to reduce traffic at the intersection of MD 650 & Powder Mill Road

NOTE: Traffic Calming is also proposed along Elton Road in order to reduce speeds and enhance safety

White Oak LATIP Analysis

LENHART TRAFFIC CONSULTING, INC.
 645 BALTIMORE ANNAPOLIS BLVD, SUITE 214
 SEVERNA PARK, MD 21146
 www.lenharttraffic.com

Proposed Lane Use
 & Traffic Control Devices

➔ - Existing ➔ - Proposed

**Exhibit
 10**

Appendix A

Supplemental Information
Turning Movement Counts

Maryland Department of Transportation
 State Highway Administration Data Services Engineering Division
 Turning Movement Count Study - Field Sheet

Station ID: S1999150073

County: Montgomery

Comments: LOS AM: A(0.62) PM: B(0.63)

Date: Tuesday 01/13/2015

Town: none

Location: MD 650 at ELTON RD

Weather: Sunny

Interval: 15 min

(dd):

PEAK HOURS	AM PERIOD 6:00AM-12:00PM	Start	End	Volume	LOS	V/C	PM PERIOD 12:00PM-19:00P	Start	End	Volume	LOS	V/C
		07:45	08:45	4684	A	0.62		17:15	18:15	4436	B	0.63

Hour Begin	MD 650					MD 650					Elton Rd					No Entrance					Grand Total
	From North					From South					From East					From West					
	U.Tur	Left	Through	Right	TOTAL	U.Turn	Left	Throug	Right	TOTAL	U.Turn	Left	Throug	RIGHT	TOTAL	U.Turn	Left	Through	Right	TOTAL	
6:00	0	1	340	0	341	0	0	207	11	218	0	6	0	2	8	0	0	0	0	0	567
6:15	0	1	367	0	368	0	0	304	15	319	0	15	0	2	17	0	0	0	0	0	704
6:30	0	14	488	0	502	0	0	341	38	379	0	15	0	4	19	0	0	0	0	0	900
6:45	0	4	492	0	496	0	0	425	23	448	0	31	0	4	35	0	0	0	0	0	979
7:00	0	2	540	0	542	0	0	475	30	505	0	24	0	8	32	0	0	0	0	0	1079
7:15	0	2	608	0	610	0	0	482	42	524	0	40	0	2	42	0	0	0	0	0	1176
7:30	0	10	573	0	583	2	0	530	34	564	0	32	0	7	39	0	0	0	0	0	1186
7:45	0	16	545	0	561	0	0	572	52	624	0	25	0	9	34	0	0	0	0	0	1219
8:00	0	9	520	0	529	0	0	500	35	535	0	19	0	4	23	0	0	0	0	0	1087
8:15	0	12	606	0	618	0	0	486	30	516	0	25	0	5	30	0	0	0	0	0	1164
8:30	0	12	616	0	628	0	0	513	45	558	0	25	0	3	28	0	0	0	0	0	1214
8:45	0	4	532	0	536	0	0	507	41	548	0	14	0	6	20	0	0	0	0	0	1104
9:00	1	5	393	0	398	0	0	506	41	547	0	28	0	6	34	0	0	0	0	0	979
9:15	0	10	409	0	419	0	0	495	42	537	0	29	0	7	36	0	0	0	0	0	992
9:30	0	16	397	0	413	0	0	366	65	431	0	26	0	6	32	0	0	0	0	0	876
9:45	0	3	387	0	390	0	0	305	70	375	0	28	0	15	43	0	0	0	0	0	808
10:00	0	2	384	0	386	0	0	336	74	410	0	27	0	9	36	0	0	0	0	0	832
10:15	0	2	382	0	384	0	0	286	78	364	0	33	0	10	43	0	0	0	0	0	791
10:30	0	2	293	0	295	0	0	302	62	364	0	52	0	17	69	0	0	0	0	0	728
10:45	0	1	338	0	339	0	0	279	58	337	0	25	0	14	39	0	0	0	0	0	715

Station ID: S1999150073

County: Montgomery

Comments: LOS AM: A(0.62) PM: B(0.63)

Date: Tuesday 01/13/2015

Town: none

Location: MD 650 at ELTON RD

Weather: Sunny

Interval: 15 min

(dd):

PEAK HOURS	AM PERIOD 6:00AM-12:00PM			PM PERIOD 12:00PM-19:00P			LOS	V/C	Start	End	Volume	LOS	V/C
	07:45	08:45	4684	17:15	18:15	4436							

11:00	0	4	265	0	269	0	0	300	61	361	0	32	0	9	41	0	0	0	0	0	671
11:15	0	14	318	0	332	0	0	279	71	350	0	34	0	18	52	0	0	0	0	0	734
11:30	0	5	336	0	341	0	0	301	59	360	0	38	0	15	53	0	0	0	0	0	754
11:45	0	16	308	0	324	0	0	288	73	361	0	32	0	10	42	0	0	0	0	0	727
12:00	2	12	374	0	386	0	0	303	78	381	0	47	0	17	64	0	0	0	0	0	831
12:15	2	12	411	0	423	0	0	300	123	423	0	54	0	11	65	0	0	0	0	0	911
12:30	1	8	402	0	410	1	0	272	112	384	0	62	0	12	74	0	0	0	0	0	868
12:45	0	16	322	0	338	0	0	322	131	453	0	43	0	8	51	0	0	0	0	0	842
13:00	0	9	316	0	325	0	0	329	104	433	0	40	0	6	46	0	0	0	0	0	804
13:15	0	6	311	0	317	0	0	302	118	420	0	36	0	10	46	0	0	0	0	0	783
13:30	0	5	289	0	294	0	0	343	97	440	0	34	0	2	36	0	0	0	0	0	770
13:45	1	5	267	0	272	0	0	327	84	411	0	29	0	3	32	0	0	0	0	0	715
14:00	0	0	260	0	260	0	0	315	85	400	0	35	0	4	39	0	0	0	0	0	699
14:15	0	7	322	0	329	0	0	348	105	453	0	43	0	3	46	0	0	0	0	0	828
14:30	0	4	353	0	357	0	0	302	136	438	0	36	0	10	46	0	0	0	0	0	841
14:45	0	15	315	0	330	0	0	298	149	447	0	22	0	2	24	0	0	0	0	0	801
15:00	0	8	293	0	301	0	0	388	137	525	0	17	0	0	17	0	0	0	0	0	843
15:15	0	5	344	0	349	0	0	406	64	470	0	23	0	1	24	0	0	0	0	0	843
15:30	0	12	397	0	409	0	0	417	58	475	0	43	0	4	47	0	0	0	0	0	931
15:45	0	7	341	0	348	0	0	509	72	581	0	43	0	15	58	0	0	0	0	0	987
16:00	2	13	369	0	382	0	0	486	87	573	0	39	0	12	51	0	0	0	0	0	1006
16:15	0	8	445	0	453	0	0	492	66	558	0	70	0	0	70	0	0	0	0	0	1081
16:30	1	2	399	0	401	0	0	516	65	581	0	47	0	9	56	0	0	0	0	0	1038
16:45	0	4	344	0	348	0	0	495	65	560	0	57	0	5	62	0	0	0	0	0	970
17:00	0	4	440	0	444	0	0	515	91	606	0	62	0	15	77	0	0	0	0	0	1127
17:15	0	3	462	0	465	0	0	561	58	619	0	64	0	11	75	0	0	0	0	0	1159

Station ID: S1999150073

County: Montgomery

Comments: LOS AM: A(0.62) PM: B(0.63)

Date: Tuesday 01/13/2015

Town: none

Location: MD 650 at ELTON RD

Weather: Sunny

Interval (dd): 15 min

PEAK HOURS	AM PERIOD		Start			End			Volume			LOS			V/C		
	6:00AM-12:00PM		07:45	08:45	4684	A	0.62	PM PERIOD			12:00PM-19:00P			17:15	18:15	4436	B

17:30	0	0	346	0	346	0	0	510	91	601	0	43	0	15	58	0	0	0	0	0	1005
17:45	0	6	462	0	468	0	0	537	106	643	0	32	0	1	33	0	0	0	0	0	1144
18:00	0	3	493	0	496	0	0	481	72	553	0	64	0	15	79	0	0	0	0	0	1128
18:15	0	12	375	0	387	0	0	501	54	555	0	68	0	7	75	0	0	0	0	0	1017
18:30	0	11	328	0	339	0	0	472	56	528	0	32	0	4	36	0	0	0	0	0	903
18:45	0	5	257	0	262	0	0	459	31	490	0	18	0	0	18	0	0	0	0	0	770
TOTAL:	10	369	20474	0	20843	3	0	20891	3645	24536	0	1858	0	394	2252	0	0	0	0	0	47631
AM Peak:	0	49	2287	0	2336	0	0	2071	162	2233	0	94	0	21	115	0	0	0	0	0	4684
PM Peak:	0	12	1763	0	1775	0	0	2089	327	2416	0	203	0	42	245	0	0	0	0	0	4436

Station ID: S1999150073
 Date: Tuesday 01/13/2015
 Location: MD 650 at ELTON RD

County: Montgomery
 Town: none
 Weather: Sunny

Comments: LOS AM: A(0.62) PM: B(0.63)

Interval (dd): 15 min

PEAK HOURS	AM PERIOD 6:00AM-12:00PM	Start	End	Volume	LOS	V/C	PM PERIOD 12:00PM-19:00P	Start	End	Volume	LOS	V/C
		07:45	08:45	4684	A	0.62		17:15	18:15	4436	B	0.63

Hour Ending	MD 650 North Leg			MD 650 South Leg			Elton Rd East Leg			No Entrance West Leg		
	School Children	Pedestrians	Bicycles	School Children	Pedestrians	Bicycles	School Children	Pedestrians	Bicycles	School Children	Pedestrians	Bicycles
6:00	0	0	0	0	0	0	0	2	0	0	0	0
6:15	0	0	0	0	1	0	0	0	0	0	0	0
6:30	0	0	0	0	1	0	0	0	0	0	0	0
6:45	0	0	0	0	0	0	0	3	0	0	0	0
7:00	0	0	0	0	0	0	0	0	0	0	0	0
7:15	0	0	0	0	1	0	0	1	0	0	0	0
7:30	0	0	0	0	0	0	0	1	0	0	0	0
7:45	0	0	0	0	0	0	0	1	0	0	0	0
8:00	0	0	0	0	0	0	0	0	0	0	0	0
8:15	0	0	0	0	0	0	0	2	0	0	0	0
8:30	0	0	0	0	0	0	0	0	0	0	0	0
8:45	0	0	0	0	1	0	0	2	0	0	0	0
9:00	0	0	0	0	0	0	0	0	0	0	0	0
9:15	0	0	0	0	0	0	0	2	0	0	0	0
9:30	0	0	0	0	1	0	0	2	0	0	0	0
9:45	0	0	0	0	0	0	0	0	0	0	0	0
10:00	0	0	0	0	0	0	0	2	0	0	0	0
10:15	0	0	0	0	0	0	0	2	0	0	0	0
10:30	0	0	0	0	0	0	0	0	0	0	0	0
10:45	0	0	0	0	1	0	0	1	0	0	0	0
11:00	0	0	0	0	0	0	0	1	0	0	0	0
11:15	0	0	0	0	0	0	0	3	0	0	0	0
11:30	0	0	0	0	0	0	0	0	0	0	0	0
11:45	0	0	0	0	0	0	0	0	0	0	0	0
12:00	0	0	0	0	0	0	0	2	0	0	0	0
12:15	0	0	0	0	1	0	0	1	0	0	0	0
12:30	0	0	0	0	0	0	0	0	0	0	0	0
12:45	0	0	0	0	0	0	0	2	0	0	0	0

Station ID: S1999150073
 Date: Tuesday 01/13/2015
 Location: MD 650 at ELTON RD
 Interval (dd): 15 min

County: Montgomery
 Town: none
 Weather: Sunny

Comments: LOS AM: A(0.62) PM: B(0.63)

PEAK HOURS	AM PERIOD 6:00AM-12:00PM	Start	End	Volume	LOS	V/C	PM PERIOD 12:00PM-19:00P	Start	End	Volume	LOS	V/C
		07:45	08:45	4684	A	0.62		17:15	18:15	4436	B	0.63

13:00	0	0	0	0	0	0	0	0	0	0	0	0
13:15	0	0	0	0	0	0	0	0	0	0	0	0
13:30	0	0	0	0	0	0	0	0	0	0	0	0
13:45	0	0	0	0	0	0	0	0	0	0	0	0
14:00	0	0	0	0	0	0	0	0	0	0	0	0
14:15	0	0	0	0	1	0	0	0	0	0	0	0
14:30	0	0	0	0	0	0	0	0	0	0	0	0
14:45	0	0	0	0	1	0	0	0	0	0	0	0
15:00	0	0	0	0	0	0	0	1	0	0	0	0
15:15	0	0	0	0	1	0	0	0	0	0	0	0
15:30	0	0	0	0	0	0	0	0	0	0	0	0
15:45	0	0	0	0	0	0	0	0	0	0	0	0
16:00	0	0	0	0	0	0	0	0	0	0	0	0
16:15	0	0	0	0	1	0	0	0	0	0	0	0
16:30	0	0	0	0	0	0	0	0	0	0	0	0
16:45	0	0	0	0	0	0	0	0	0	0	0	0
17:00	0	0	0	0	0	0	0	0	0	0	0	0
17:15	0	0	0	0	0	0	0	0	0	0	0	0
17:30	0	0	0	0	1	0	0	0	0	0	0	0
17:45	0	0	0	0	0	0	0	0	0	0	0	0
18:00	0	0	0	0	0	0	0	0	0	0	0	0
18:15	0	0	0	0	1	0	0	0	0	0	0	0
18:30	0	0	0	0	0	0	0	0	0	0	0	0
18:45	0	0	0	0	0	0	0	0	0	0	0	0
Total:	0	0	0	0	13	0	0	31	0	0	0	0
AM Peak:	0	0	0	0	0	0	0	3	0	0	0	0
PM Peak:	0	0	0	0	1	0	0	0	0	0	0	0

Station ID: S1999150073

County: Montgomery

Comments: LOS AM: A(0.62) PM: B(0.63)

Date: Tuesday 01/13/2015

Town: none

Location: MD 650 at ELTON RD

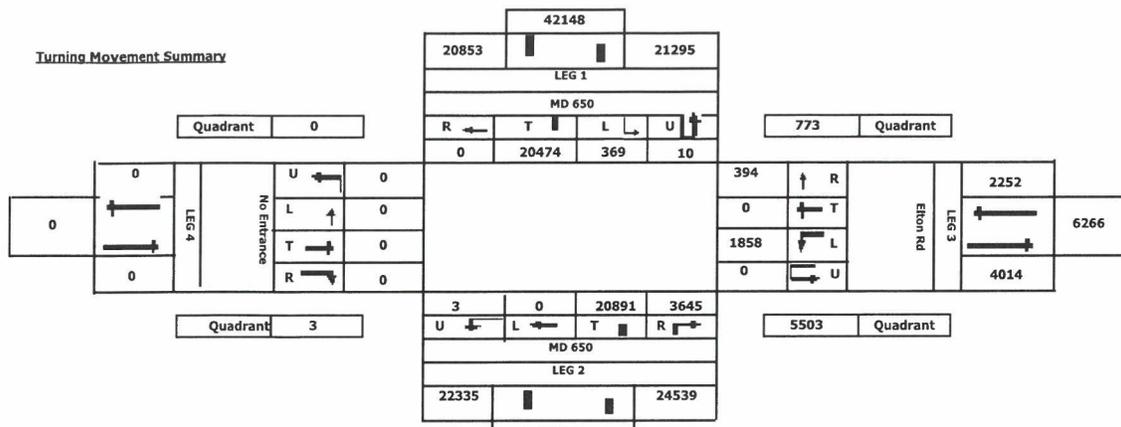
Weather: Sunny

Interval: 15 min

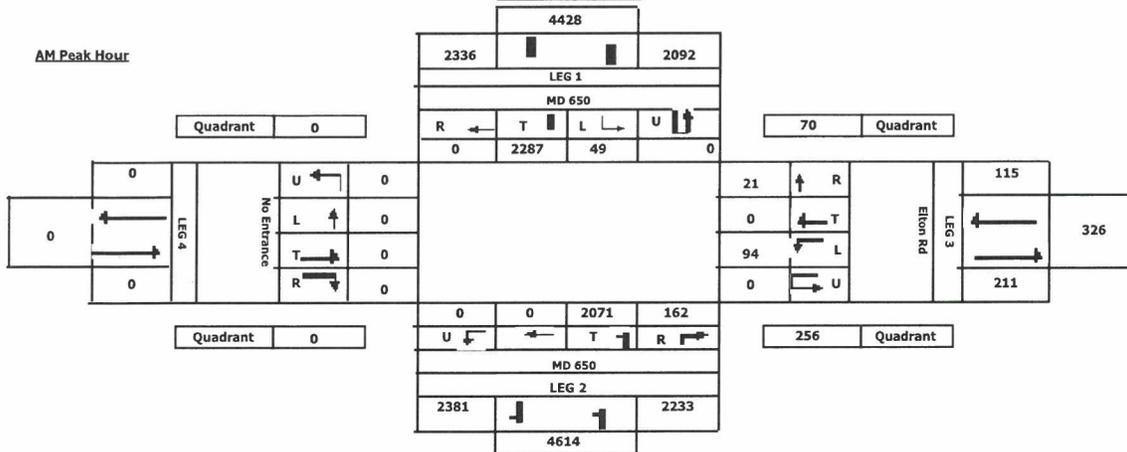
(dd):

PEAK HOURS	AM PERIOD 6:00AM-12:00PM	Start	End	Volume	LOS	V/C	PM PERIOD 12:00PM-19:00P	Start	End	Volume	LOS	V/C
		07:45	08:45	4684	A	0.62		17:15	18:15	4436	B	0.63

Turning Movement Summary



AM Peak Hour

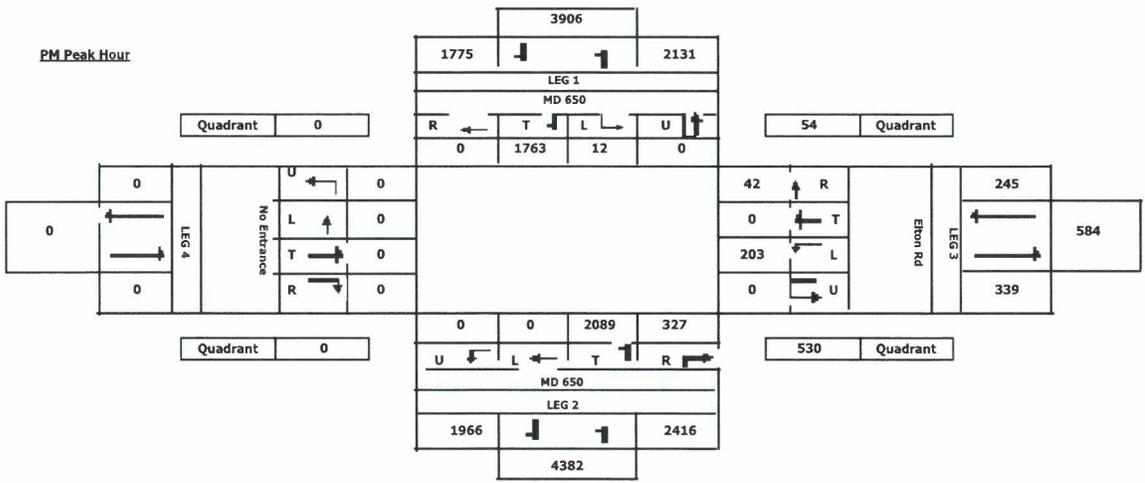


Station ID: S1999150073
 Date: Tuesday 01/13/2015
 Location: MD 650 at ELTON RD
 Interval (dd): 15 min

County: Montgomery
 Town: none
 Weather: Sunny

Comments: LOS AM: A(0.62) PM: B(0.63)

PEAK HOURS	AM PERIOD 6:00AM-12:00PM	Start	End	Volume	LOS	V/C	PM PERIOD 12:00PM-19:00P	Start	End	Volume	LOS	V/C
		07:45	08:45	4684	A	0.62		17:15	18:15	4436	B	0.63



Maryland Department of Transportation
State Highway Administration Data Services Engineering Division
Turning Movement Count Study - Field Sheet

Station ID: S1998150181
Date: Thursday 01/22/2015
Location: MD 650 at Powder Mill Rd
Interval (dd): 15 min

County: Montgomery
Town: none
Weather: Sunny

Comments: LOS AM: D(0.85) PM: D(0.85)

PEAK HOURS	AM PERIOD 6:00AM-12:00PM	Start	End	Volume	LOS	V/C	PM PERIOD 12:00PM-19:00P	Start	End	Volume	LOS	V/C
		07:15	08:15	5003	D	0.85		17:00	18:00	5155	D	0.85

Hour Begin	MD 650					MD 650					Powder Mill Rd					Powder Mill Rd					Grand Total
	From North					From South					From East					From West					
	U.Turn	Left	Through	Right	TOTAL	U.Turn	Left	Throug	Right	TOTAL	U.Turn	Left	Throug	RIGHT	TOTAL	U.Turn	Left	Through	Right	TOTAL	
6:00	0	24	222	3	249	5	6	189	28	223	0	76	3	12	91	0	2	0	8	10	573
6:15	1	16	281	1	298	7	9	304	24	337	0	108	6	23	137	0	5	0	8	13	785
6:30	0	12	432	3	447	13	5	316	27	348	0	138	12	16	166	0	4	1	9	14	975
6:45	0	19	422	1	442	13	8	364	27	399	0	148	2	34	184	0	2	2	13	17	1042
7:00	2	19	466	2	487	6	11	346	41	398	0	191	4	44	239	0	2	0	11	13	1137
7:15	0	33	521	2	556	7	8	384	37	409	0	207	6	26	239	0	4	4	10	18	1222
7:30	0	25	581	1	607	6	9	427	31	467	0	222	5	26	253	0	3	0	13	16	1343
7:45	2	19	506	3	528	4	14	439	37	490	0	180	3	26	209	0	4	3	8	15	1242
8:00	0	18	471	2	491	9	17	464	42	523	0	124	3	32	159	0	5	1	17	23	1196
8:15	2	13	459	5	477	7	9	463	33	505	1	130	2	43	175	0	1	4	8	13	1170
8:30	0	25	429	0	454	7	8	467	31	506	0	143	5	34	182	0	8	3	12	23	1165
8:45	1	22	403	5	430	3	13	458	29	500	0	121	4	36	161	0	2	0	9	11	1102
9:00	3	28	411	3	442	4	7	420	31	458	0	102	3	29	134	0	1	2	11	14	1048
9:15	1	19	385	4	408	8	10	331	41	382	0	111	0	32	143	0	2	3	10	15	948
9:30	0	25	343	1	369	10	9	307	35	351	0	97	5	25	127	0	6	3	16	25	872
9:45	3	33	309	5	347	5	8	285	28	321	0	69	6	28	103	0	8	0	21	29	800
10:00	0	26	319	1	346	0	11	271	33	315	1	86	1	20	107	0	7	2	18	27	795
10:15	1	17	299	1	317	4	16	267	35	318	0	65	3	22	90	0	10	1	19	30	755
10:30	1	18	263	3	284	9	12	216	28	256	0	73	2	21	96	0	3	9	12	24	660
10:45	0	29	248	3	280	12	12	236	31	279	0	67	2	20	89	0	7	4	18	29	677

Station ID: S1998150181

County: Montgomery

Comments: LOS AM: D(0.85) PM: D(0.85)

Date: Thursday 01/22/2015

Town: none

Location: MD 650 at Powder Mill Rd

Weather: Sunny

Interval (dd): 15 min

PEAK HOURS	AM PERIOD 6:00AM-12:00PM					PM PERIOD 12:00PM-19:00P				
	Start 07:15	End 08:15	Volume 5003	LOS D	V/C 0.85	Start 17:00	End 18:00	Volume 5155	LOS D	V/C 0.85

11:00	1	27	229	4	260	10	11	187	31	229	1	61	3	24	88	0	6	4	19	29	606
11:15	3	36	250	1	287	17	10	211	28	249	1	67	5	25	97	0	9	4	19	32	665
11:30	1	30	255	7	292	12	8	218	26	252	0	93	2	23	118	0	5	4	16	25	687
11:45	3	37	228	1	266	11	13	246	35	294	0	69	2	27	98	0	6	2	16	24	682
12:00	0	45	268	2	315	10	9	258	33	300	0	90	1	26	117	0	8	5	18	31	763
12:15	2	41	256	1	298	11	6	264	31	301	0	79	9	24	112	0	9	7	11	27	738
12:30	0	35	270	2	307	16	24	249	34	307	0	79	3	30	112	0	8	2	15	25	751
12:45	0	31	297	3	331	14	11	254	39	304	0	79	5	32	116	0	16	7	13	36	787
13:00	1	36	262	1	299	18	8	285	36	329	1	64	2	45	111	0	8	4	12	24	763
13:15	2	35	238	2	275	21	13	306	35	354	1	81	3	46	130	0	8	5	18	31	790
13:30	1	24	244	1	269	10	12	259	35	306	0	72	2	46	120	0	6	1	22	29	724
13:45	2	29	258	3	290	11	8	280	38	326	0	93	5	36	134	0	10	4	19	33	783
14:00	0	29	280	5	314	17	13	293	37	343	0	83	6	44	133	0	11	4	15	30	820
14:15	1	31	305	2	338	17	11	323	36	370	0	90	3	39	132	0	11	5	16	32	872
14:30	1	30	323	6	359	15	10	326	42	378	0	118	7	34	159	0	11	8	23	42	938
14:45	0	34	329	3	366	7	15	351	43	409	0	95	8	42	145	0	6	5	20	31	951
15:00	2	35	297	1	333	17	12	416	40	468	0	115	3	55	173	0	20	2	12	34	1008
15:15	2	43	399	0	442	12	11	401	59	471	1	113	1	61	175	0	7	6	18	31	1119
15:30	0	40	414	3	457	0	10	413	62	485	0	110	3	53	166	0	4	3	16	23	1131
15:45	5	35	449	4	488	13	9	456	65	530	0	131	2	46	179	0	7	5	18	30	1227
16:00	0	42	456	2	500	11	13	437	66	516	0	128	2	51	181	0	16	2	19	37	1234
16:15	0	49	462	2	513	8	8	479	57	544	0	124	1	63	188	0	4	6	10	20	1265
16:30	3	50	474	3	527	10	5	456	44	505	0	120	3	52	175	0	11	6	14	31	1238
16:45	0	41	485	1	527	15	10	477	57	544	0	111	6	58	175	0	4	6	20	30	1276
17:00	1	54	490	3	547	11	5	446	44	495	0	99	3	63	165	0	15	2	21	38	1245
17:15	2	56	515	4	575	11	9	493	64	566	0	122	5	60	187	0	8	4	15	27	1355

Station ID: S1998150181

County: Montgomery

Comments: LOS AM: D(0.85) PM: D(0.85)

Date: Thursday 01/22/2015

Town: none

Location: MD 650 at Powder Mill Rd

Weather: Sunny

Interval (dd): 15 min

PEAK HOURS	AM PERIOD 6:00AM-12:00PM					PM PERIOD 12:00PM-19:00P				
	Start	End	Volume	LOS	V/C	Start	End	Volume	LOS	V/C
	07:15	08:15	5003	D	0.85	17:00	18:00	5155	D	0.85

17:30	1	49	486	1	536	20	11	457	49	517	0	109	7	62	178	0	8	6	21	35	1266
17:45	1	55	468	2	525	11	10	491	62	563	0	92	10	75	177	0	7	4	13	24	1289
18:00	0	34	409	2	445	12	14	480	55	549	0	118	4	58	180	0	10	2	9	21	1195
18:15	1	39	385	1	425	13	10	449	53	512	0	111	1	40	152	0	15	4	4	23	1112
18:30	2	26	414	1	441	7	11	431	55	497	0	82	4	59	145	0	9	4	11	24	1107
18:45	1	32	317	1	350	6	7	388	36	431	0	73	0	52	125	0	11	1	12	24	930
TOTAL:	56	1650	18982	124	20756	533	539	18414	2076	21029	7	5529	198	2000	7727	0	380	176	756	1312	50824
AM Peak:	2	95	2079	8	2182	26	48	1694	147	1889	0	733	17	110	860	0	16	8	48	72	5003
PM Peak:	5	214	1959	10	2183	53	35	1887	219	2141	0	422	25	260	707	0	38	16	70	124	5155

Station ID: S1998150181

County: Montgomery

Comments: LOS AM: D(0.85) PM: D(0.85)

Date: Thursday 01/22/2015

Town: none

Location: MD 650 at Powder Mill Rd

Weather: Sunny

Interval (dd): 15 min

PEAK HOURS	AM PERIOD 6:00AM-12:00PM	Start	End	Volume	LOS	V/C	PM PERIOD 12:00PM-19:00P	Start	End	Volume	LOS	V/C
		07:15	08:15	5003	D	0.85		17:00	18:00	5155	D	0.85

Hour Ending	MD 650 North Leg			MD 650 South Leg			Powder Mill Rd East Leg			Powder Mill Rd West Leg		
	School Children	Pedestrians	Bicycles	School Children	Pedestrians	Bicycles	School Children	Pedestrians	Bicycles	School Children	Pedestrians	Bicycles
6:00	0	0	0	0	4	0	0	0	0	0	0	0
6:15	0	0	0	0	7	0	0	4	0	0	5	0
6:30	0	1	0	0	5	0	0	2	0	0	1	0
6:45	0	0	0	0	5	0	0	2	0	0	1	0
7:00	0	1	0	0	10	0	0	4	0	0	4	0
7:15	0	1	0	0	6	0	0	6	0	0	8	0
7:30	0	1	0	0	7	0	0	3	0	0	5	0
7:45	0	0	0	0	7	0	0	4	0	0	4	0
8:00	0	0	0	0	1	0	0	0	0	0	1	0
8:15	0	1	0	0	3	0	0	3	0	0	7	0
8:30	0	0	0	0	3	0	0	0	0	0	1	0
8:45	0	0	0	0	6	0	0	2	0	0	6	0
9:00	0	1	0	0	12	0	0	6	0	0	5	0
9:15	0	0	0	0	8	0	0	0	0	0	5	0
9:30	0	2	0	0	6	0	0	0	0	0	3	0
9:45	0	4	0	0	14	0	0	0	0	0	12	0
10:00	0	2	0	0	6	0	0	0	0	0	9	0
10:15	0	4	0	0	7	0	0	2	0	0	6	0
10:30	0	1	0	0	3	0	0	3	0	0	13	0
10:45	0	3	0	0	5	0	0	1	0	0	4	0
11:00	0	2	0	0	7	0	0	4	0	0	6	0
11:15	0	2	0	0	7	0	0	0	0	0	7	0
11:30	0	6	0	0	4	0	0	1	0	0	2	0
11:45	0	1	0	0	6	0	0	0	0	0	1	0
12:00	0	3	0	0	4	0	0	0	0	0	3	0
12:15	0	0	0	0	3	0	0	0	0	0	1	0
12:30	0	1	0	0	11	0	0	0	0	0	7	0
12:45	0	1	0	0	9	0	0	0	0	0	5	0

Station ID: S1998150181

County: Montgomery

Comments: LOS AM: D(0.85) PM: D(0.85)

Date: Thursday 01/22/2015

Town: none

Location: MD 650 at Powder Mill Rd

Weather: Sunny

Interval (dd): 15 min

PEAK HOURS	AM PERIOD 6:00AM-12:00PM					PM PERIOD 12:00PM-19:00P				
	Start 07:15	End 08:15	Volume 5003	LOS D	V/C 0.85	Start 17:00	End 18:00	Volume 5155	LOS D	V/C 0.85

13:00	0	0	0	0	16	0	0	6	0	0	8	0
13:15	0	1	0	0	10	0	0	2	0	0	0	0
13:30	0	0	0	0	12	0	0	0	0	0	2	0
13:45	0	2	0	0	4	0	0	3	0	0	4	0
14:00	0	0	0	0	23	0	0	11	0	0	6	0
14:15	0	1	0	0	16	0	0	4	0	0	4	0
14:30	0	1	0	0	5	0	0	1	0	0	4	0
14:45	0	1	0	0	11	0	0	3	0	0	1	0
15:00	0	0	0	0	6	0	0	1	0	0	2	0
15:15	0	1	0	0	5	0	0	1	0	0	8	0
15:30	0	5	0	0	4	0	0	1	0	0	3	0
15:45	0	1	0	0	5	0	0	0	0	0	1	0
16:00	0	0	0	0	7	0	0	1	0	0	2	0
16:15	0	1	0	0	12	0	0	0	0	0	1	0
16:30	0	0	0	0	8	0	0	4	0	0	8	0
16:45	0	2	0	0	6	0	0	4	0	0	3	0
17:00	0	3	0	0	7	0	0	1	0	0	2	0
17:15	0	3	0	0	6	0	0	8	0	0	1	0
17:30	0	3	0	0	12	0	0	3	0	0	3	0
17:45	0	2	0	0	8	0	0	1	0	0	2	0
18:00	0	0	0	0	6	0	0	2	0	0	0	0
18:15	0	0	0	0	8	0	0	2	0	0	2	0
18:30	0	0	0	0	4	0	0	1	0	0	1	0
18:45	0	0	0	0	3	0	0	0	0	0	1	0
Total:	0	65	0	0	380	0	0	107	0	0	201	0
AM Peak:	0	2	0	0	21	0	0	13	0	0	18	0
PM Peak:	0	11	0	0	33	0	0	13	0	0	8	0

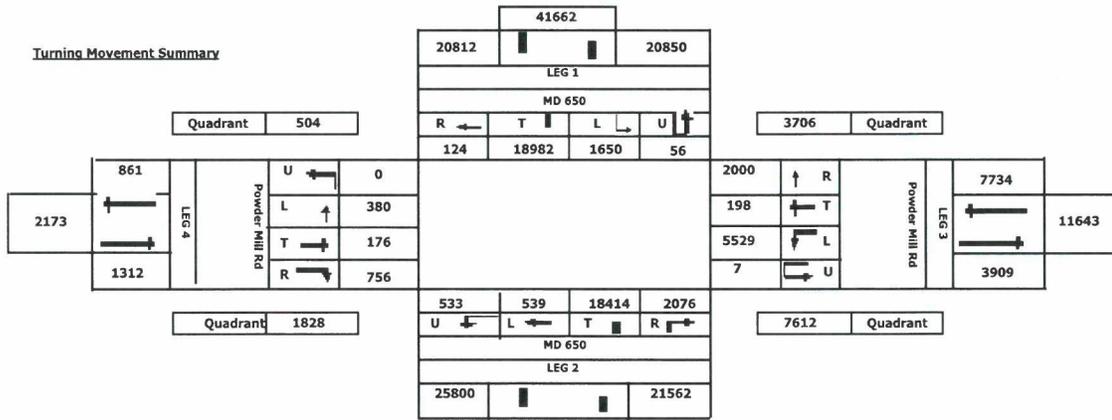
Station ID: S1998150181
 Date: Thursday 01/22/2015
 Location: MD 650 at Powder Mill Rd
 Interval (dd): 15 min

County: Montgomery
 Town: none
 Weather: Sunny

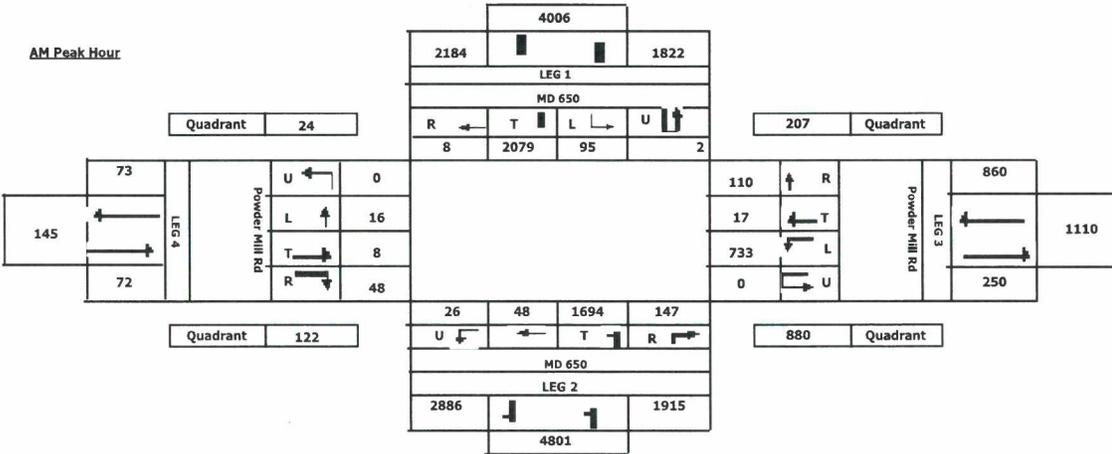
Comments: LOS AM: D(0.85) PM: D(0.85)

PEAK HOURS	AM PERIOD 6:00AM-12:00PM	Start	End	Volume	LOS	V/C	PM PERIOD 12:00PM-19:00P	Start	End	Volume	LOS	V/C
		07:15	08:15	5003	D	0.85		17:00	18:00	5155	D	0.85

Turning Movement Summary



AM Peak Hour



Station ID: S1998150181

County: Montgomery

Comments: LOS AM: D(0.85) PM: D(0.85)

Date: Thursday 01/22/2015

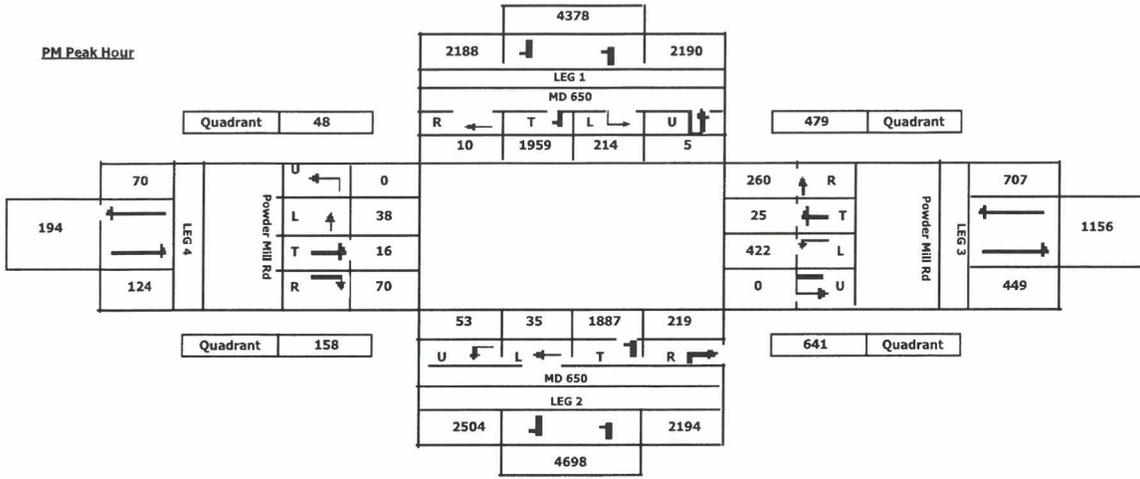
Town: none

Location: MD 650 at Powder Mill Rd

Weather: Sunny

Interval (dd): 15 min

PEAK HOURS	AM PERIOD 6:00AM-12:00PM	Start	End	Volume	LOS	V/C	PM PERIOD 12:00PM-19:00P	Start	End	Volume	LOS	V/C
		07:15	08:15	5003	D	0.85		17:00	18:00	5155	D	0.85



Appendix B

Synchro/SimTraffic Worksheets

HCM Signalized Intersection Capacity Analysis

1: MD 650 & Powder Mill Rd

08/07/2017

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	57	25	97	844	21	135	106	2155	170	112	2517	16
Future Volume (vph)	57	25	97	844	21	135	106	2155	170	112	2517	16
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1800	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5	4.5	5.0	5.0		3.0	4.0		5.0	5.0	
Lane Util. Factor	1.00	1.00	1.00	0.91	0.91		1.00	0.91		1.00	0.91	
Fr _t	1.00	1.00	0.85	1.00	0.94		1.00	0.99		1.00	1.00	
Fl _t Protected	0.95	1.00	1.00	0.95	0.97		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1711	1801	1531	3113	1498		1711	4606		1711	4911	
Fl _t Permitted	0.95	1.00	1.00	0.95	0.97		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1711	1801	1531	3113	1498		1711	4606		1711	4911	
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	59	26	100	870	22	139	109	2222	175	115	2595	16
RTOR Reduction (vph)	0	0	0	0	13	0	0	5	0	0	0	0
Lane Group Flow (vph)	59	26	100	696	322	0	109	2392	0	115	2611	0
Turn Type	Split	NA	Perm	Split	NA		Prot	NA		Prot	NA	
Protected Phases	3	3		4	4		1	5		6	2	
Permitted Phases			3									
Actuated Green, G (s)	17.1	17.1	17.1	38.4	38.4		9.0	87.0		10.0	89.0	
Effective Green, g (s)	19.1	19.1	19.1	40.4	40.4		12.0	90.0		12.0	91.0	
Actuated g/C Ratio	0.11	0.11	0.11	0.22	0.22		0.07	0.50		0.07	0.51	
Clearance Time (s)	6.5	6.5	6.5	7.0	7.0		6.0	7.0		7.0	7.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	0.2		3.0	0.2	
Lane Grp Cap (vph)	181	191	162	698	336		114	2303		114	2482	
v/s Ratio Prot	0.03	0.01		c0.22	0.21		0.06	c0.52		0.07	c0.53	
v/s Ratio Perm			c0.07									
v/c Ratio	0.33	0.14	0.62	1.00	0.96		0.96	1.04		1.01	1.05	
Uniform Delay, d ₁	74.5	73.0	77.0	69.7	69.0		83.7	45.0		84.0	44.5	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.05	0.80		0.94	0.89	
Incremental Delay, d ₂	1.1	0.3	6.8	33.1	37.6		63.3	28.3		75.9	31.6	
Delay (s)	75.5	73.3	83.8	102.8	106.5		150.9	64.1		155.1	71.2	
Level of Service	E	E	F	F	F		F	E		F	E	
Approach Delay (s)		79.7			104.0			67.9			74.7	
Approach LOS		E			F			E			E	

Intersection Summary

HCM 2000 Control Delay	76.9	HCM 2000 Level of Service	E
HCM 2000 Volume to Capacity ratio	1.00		
Actuated Cycle Length (s)	180.0	Sum of lost time (s)	18.5
Intersection Capacity Utilization	93.1%	ICU Level of Service	F
Analysis Period (min)	15		
c Critical Lane Group			

HCM Signalized Intersection Capacity Analysis

3: MD 650 & Elton Rd

08/07/2017

						
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	  		  			  
Traffic Volume (vph)	100	23	2374	170	57	2633
Future Volume (vph)	100	23	2374	170	57	2633
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0		2.5	2.0	2.5	2.5
Lane Util. Factor	0.97		0.91	1.00	1.00	0.91
Frt	0.97		1.00	0.85	1.00	1.00
Flt Protected	0.96		1.00	1.00	0.95	1.00
Satd. Flow (prot)	3263		4916	1531	1711	4916
Flt Permitted	0.96		1.00	1.00	0.05	1.00
Satd. Flow (perm)	3263		4916	1531	83	4916
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	106	24	2526	181	61	2801
RTOR Reduction (vph)	6	0	0	0	0	0
Lane Group Flow (vph)	124	0	2526	181	61	2801
Turn Type	Prot		NA	pm+ov	Perm	NA
Protected Phases	3		2 4 9	3		6 4 9
Permitted Phases	3			2 4 9	6 4 9	
Actuated Green, G (s)	13.2		154.3	167.5	154.3	154.3
Effective Green, g (s)	16.2		158.3	170.5	158.3	158.3
Actuated g/C Ratio	0.09		0.88	0.95	0.88	0.88
Clearance Time (s)	6.0			6.0		
Vehicle Extension (s)	4.0			4.0		
Lane Grp Cap (vph)	293		4323	1467	72	4323
v/s Ratio Prot	c0.04		0.51	0.01		0.57
v/s Ratio Perm				0.11	c0.73	
v/c Ratio	0.42		0.58	0.12	0.85	0.65
Uniform Delay, d1	77.5		2.7	0.3	5.1	3.0
Progression Factor	1.00		1.33	1.00	1.04	0.61
Incremental Delay, d2	1.3		0.2	0.0	24.2	0.1
Delay (s)	78.8		3.8	0.3	29.5	2.0
Level of Service	E		A	A	C	A
Approach Delay (s)	78.8		3.5			2.5
Approach LOS	E		A			A

Intersection Summary			
HCM 2000 Control Delay	4.8	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.83		
Actuated Cycle Length (s)	180.0	Sum of lost time (s)	11.5
Intersection Capacity Utilization	61.1%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis
 1: MD 650 & Powder Mill Rd

08/07/2017



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations	↖	↑	↗	↖↗	↕		↖	↑↑↑		↖	↑↑↑	↗
Traffic Volume (vph)	71	32	109	496	36	300	194	2160	250	250	2456	43
Future Volume (vph)	71	32	109	496	36	300	194	2160	250	250	2456	43
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1800	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5	4.5	5.0	5.0		3.0	4.0		5.0	5.0	
Lane Util. Factor	1.00	1.00	1.00	0.91	0.91		1.00	0.91		1.00	0.91	
Fr _t	1.00	1.00	0.85	1.00	0.88		1.00	0.98		1.00	1.00	
Fl _t Protected	0.95	1.00	1.00	0.95	0.99		0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1711	1801	1531	3113	1438		1711	4585		1711	4903	
Fl _t Permitted	0.95	1.00	1.00	0.95	0.99		0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1711	1801	1531	3113	1438		1711	4585		1711	4903	
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	73	33	112	511	37	309	200	2227	258	258	2532	44
RTOR Reduction (vph)	0	0	0	0	66	0	0	8	0	0	1	0
Lane Group Flow (vph)	73	33	112	460	331	0	200	2477	0	258	2575	0
Turn Type	Split	NA	Perm	Split	NA		Prot	NA		Prot	NA	
Protected Phases	3	3		4	4		1	5		6	2	
Permitted Phases			3									
Actuated Green, G (s)	18.5	18.5	18.5	37.0	37.0		9.0	76.0		21.0	89.0	
Effective Green, g (s)	20.5	20.5	20.5	39.0	39.0		12.0	79.0		23.0	91.0	
Actuated g/C Ratio	0.11	0.11	0.11	0.22	0.22		0.07	0.44		0.13	0.51	
Clearance Time (s)	6.5	6.5	6.5	7.0	7.0		6.0	7.0		7.0	7.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0		3.0	0.2		3.0	0.2	
Lane Grp Cap (vph)	194	205	174	674	311		114	2012		218	2478	
v/s Ratio Prot	0.04	0.02		0.15	c0.23		c0.12	c0.54		c0.15	0.53	
v/s Ratio Perm			c0.07									
v/c Ratio	0.38	0.16	0.64	0.68	1.06		1.75	1.23		1.18	1.04	
Uniform Delay, d1	73.8	72.0	76.3	64.8	70.5		84.0	50.5		78.5	44.5	
Progression Factor	1.00	1.00	1.00	1.00	1.00		1.15	0.66		1.19	1.33	
Incremental Delay, d2	1.2	0.4	7.9	2.9	69.3		370.0	108.2		112.3	27.1	
Delay (s)	75.1	72.4	84.2	67.7	139.8		466.2	141.6		205.7	86.3	
Level of Service	E	E	F	E	F		F	F		F	F	
Approach Delay (s)		79.3			101.1			165.8			97.2	
Approach LOS		E			F			F			F	

Intersection Summary

HCM 2000 Control Delay	125.0	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	1.14		
Actuated Cycle Length (s)	180.0	Sum of lost time (s)	18.5
Intersection Capacity Utilization	99.3%	ICU Level of Service	F
Analysis Period (min)	15		

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis

3: MD 650 & Elton Rd

08/07/2017

						
Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations	 		  			  
Traffic Volume (vph)	215	53	2143	345	21	2018
Future Volume (vph)	215	53	2143	345	21	2018
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900
Total Lost time (s)	3.0		2.5	2.0	2.5	2.5
Lane Util. Factor	0.97		0.91	1.00	1.00	0.91
Frt	0.97		1.00	0.85	1.00	1.00
Flt Protected	0.96		1.00	1.00	0.95	1.00
Satd. Flow (prot)	3259		4916	1531	1711	4916
Flt Permitted	0.96		1.00	1.00	0.06	1.00
Satd. Flow (perm)	3259		4916	1531	105	4916
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	229	56	2280	367	22	2147
RTOR Reduction (vph)	13	0	0	0	0	0
Lane Group Flow (vph)	272	0	2280	367	22	2147
Turn Type	Prot		NA	pm+ov	Perm	NA
Protected Phases	3		2 4 9	3		6 4 9
Permitted Phases	3			2 4 9	6 4 9	
Actuated Green, G (s)	22.3		145.2	167.5	145.2	145.2
Effective Green, g (s)	25.3		149.2	170.5	149.2	149.2
Actuated g/C Ratio	0.14		0.83	0.95	0.83	0.83
Clearance Time (s)	6.0			6.0		
Vehicle Extension (s)	4.0			4.0		
Lane Grp Cap (vph)	458		4074	1467	87	4074
v/s Ratio Prot	c0.08		c0.46	0.04		0.44
v/s Ratio Perm				0.20	0.21	
v/c Ratio	0.59		0.56	0.25	0.25	0.53
Uniform Delay, d1	72.5		4.9	0.3	3.3	4.7
Progression Factor	1.00		0.56	1.00	1.89	2.02
Incremental Delay, d2	2.4		0.1	0.1	0.8	0.1
Delay (s)	75.0		2.9	0.4	7.1	9.5
Level of Service	E		A	A	A	A
Approach Delay (s)	75.0		2.6			9.5
Approach LOS	E		A			A

Intersection Summary			
HCM 2000 Control Delay	9.6	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.58		
Actuated Cycle Length (s)	180.0	Sum of lost time (s)	11.5
Intersection Capacity Utilization	55.9%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Arterial Level of Service: NB MD 650

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
Oakview Dr	4	47.4	434.7	0.1	8
Ramps 4&1	72	2.5	8.2	0.1	25
	114	0.8	8.1	0.1	37
	58	0.9	5.9	0.1	45
Ramp 2	66	32.4	41.2	0.1	9
Elton Rd	3	3.0	6.3	0.0	21
Ramp 8	143	6.8	13.5	0.1	16
	2	12.1	15.6	0.0	6
Powder Mill Rd	1	34.2	42.6	0.1	5
	5	18.6	73.4	0.6	30
Total		158.7	649.6	1.2	16

Arterial Level of Service: SB MD 650

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
Chalmers Rd	5	39.6	136.1	0.1	6
Powder Mill Rd	1	420.6	476.6	0.6	5
	2	7.8	12.9	0.1	15
Ramp 8	143	1.1	3.4	0.0	28
Elton Rd	3	3.2	8.5	0.1	25
Ramp 2	66	0.6	2.6	0.0	51
	58	2.4	13.0	0.1	29
	114	1.0	7.0	0.1	38
Ramps 4&1	72	2.7	9.6	0.1	31
Oakview Dr	4	11.1	17.0	0.1	12
Total		490.0	686.7	1.2	7

Arterial Level of Service: NB MD 650

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
Oakview Dr	4	63.9	2063.5	0.1	6
Ramps 4&1	72	2.9	8.6	0.1	23
	114	0.8	8.1	0.1	37
	58	0.8	5.8	0.1	45
Ramp 2	66	40.2	49.0	0.1	8
Elton Rd	3	3.8	7.2	0.0	18
Ramp 8	143	10.9	17.6	0.1	12
	2	12.9	16.6	0.0	6
Powder Mill Rd	1	22.4	528.1	0.1	7
	5	8.7	64.2	0.6	34
Total		167.6	2768.8	1.2	16

Arterial Level of Service: SB MD 650

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
Chalmers Rd	5	54.2	338.8	0.1	5
Powder Mill Rd	1	464.3	548.9	0.6	4
	2	8.6	13.7	0.1	14
Ramp 8	143	1.1	3.4	0.0	27
Elton Rd	3	8.4	13.7	0.1	15
Ramp 2	66	1.1	3.1	0.0	42
	58	2.2	12.9	0.1	29
	114	0.9	6.8	0.1	39
Ramps 4&1	72	2.1	9.0	0.1	33
Oakview Dr	4	11.7	17.7	0.1	11
Total		554.6	968.1	1.2	7

Total Network Performance By Run

Run Number	1	2	3	4	5	Avg
Denied Delay (hr)	674.9	630.3	565.4	568.8	551.5	598.2
Denied Del/Veh (s)	224.7	210.3	188.6	189.7	184.8	199.6
Total Delay (hr)	635.4	597.8	550.6	593.7	589.0	593.3
Total Del/Veh (s)	220.2	211.0	193.9	207.9	207.5	208.1

Total Network Performance By Run

Run Number	1	2	3	4	5	Avg
Denied Delay (hr)	1635.0	1568.1	1511.3	1615.7	1504.2	1566.9
Denied Del/Veh (s)	471.3	457.1	434.5	465.3	430.3	451.6
Total Delay (hr)	626.0	605.6	580.8	591.0	595.7	599.8
Total Del/Veh (s)	222.5	217.6	206.2	211.3	207.8	213.1

HCM Signalized Intersection Capacity Analysis

1: MD 650 & Powder Mill Rd

11/12/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Lane Configurations													
Traffic Volume (vph)	57	25	97	722	21	135	80	2155	170	112	2517	16	
Future Volume (vph)	57	25	97	722	21	135	80	2155	170	112	2517	16	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1800	1900	1900	1900	1900	
Total Lost time (s)	4.5	4.5	4.5	5.0	5.0	5.0	3.0	4.0		5.0	5.0		
Lane Util. Factor	0.91	0.86	0.91	0.91	0.91	1.00	1.00	0.91		1.00	0.91		
Frt	1.00	0.91	0.85	1.00	1.00	0.85	1.00	0.99		1.00	1.00		
Flt Protected	0.95	0.99	1.00	0.95	0.96	1.00	0.95	1.00		0.95	1.00		
Satd. Flow (prot)	1557	2814	1393	3113	1567	1531	1711	4606		1711	4911		
Flt Permitted	0.95	0.99	1.00	0.95	0.96	1.00	0.95	1.00		0.95	1.00		
Satd. Flow (perm)	1557	2814	1393	3113	1567	1531	1711	4606		1711	4911		
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	
Adj. Flow (vph)	59	26	100	744	22	139	82	2222	175	115	2595	16	
RTOR Reduction (vph)	0	0	0	0	0	117	0	3	0	0	0	0	
Lane Group Flow (vph)	47	88	50	513	253	22	82	2394	0	115	2611	0	
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA		Prot	NA		
Protected Phases	3	3		4	4		1	5		6	2		
Permitted Phases			3			4							
Actuated Green, G (s)	12.0	12.0	12.0	27.0	27.0	27.0	3.0	95.9		17.6	111.5		
Effective Green, g (s)	14.0	14.0	14.0	29.0	29.0	29.0	6.0	98.9		19.6	113.5		
Actuated g/C Ratio	0.08	0.08	0.08	0.16	0.16	0.16	0.03	0.55		0.11	0.63		
Clearance Time (s)	6.5	6.5	6.5	7.0	7.0	7.0	6.0	7.0		7.0	7.0		
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	0.2		3.0	0.2		
Lane Grp Cap (vph)	121	218	108	501	252	246	57	2530		186	3096		
v/s Ratio Prot	0.03	0.03		c0.16	0.16		c0.05	c0.52		0.07	c0.53		
v/s Ratio Perm			c0.04			0.01							
v/c Ratio	0.39	0.40	0.46	1.02	1.00	0.09	1.44	0.95		0.62	0.84		
Uniform Delay, d1	78.9	79.0	79.4	75.5	75.5	64.3	87.0	38.1		76.6	26.2		
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	0.81	0.54		0.93	0.87		
Incremental Delay, d2	2.1	1.2	3.1	46.4	57.7	0.2	260.4	7.7		4.6	2.3		
Delay (s)	81.0	80.2	82.5	121.9	133.2	64.4	330.9	28.4		75.6	25.2		
Level of Service	F	F	F	F	F	E	F	C		E	C		
Approach Delay (s)		81.1			116.3			38.4			27.3		
Approach LOS		F			F			D			C		
Intersection Summary													
HCM 2000 Control Delay			46.0									HCM 2000 Level of Service	D
HCM 2000 Volume to Capacity ratio			0.93										
Actuated Cycle Length (s)			180.0									Sum of lost time (s)	18.5
Intersection Capacity Utilization			86.2%									ICU Level of Service	E
Analysis Period (min)			15										
c Critical Lane Group													

HCM Signalized Intersection Capacity Analysis

3: MD 650 & Elton Rd

11/12/2018

													
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Lane Configurations													
Traffic Volume (vph)	0	0	0	100	148	10	0	2374	170	57	2633	0	
Future Volume (vph)	0	0	0	100	148	10	0	2374	170	57	2633	0	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	
Total Lost time (s)				3.0	6.0			2.5	2.0	2.5	2.5		
Lane Util. Factor				0.95	0.95			0.91	1.00	1.00	0.91		
Frt				1.00	0.99			1.00	0.85	1.00	1.00		
Flt Protected				0.95	1.00			1.00	1.00	0.95	1.00		
Satd. Flow (prot)				1625	1689			4916	1531	1711	4916		
Flt Permitted				0.95	1.00			1.00	1.00	0.04	1.00		
Satd. Flow (perm)				1625	1689			4916	1531	75	4916		
Peak-hour factor, PHF	1.00	1.00	1.00	0.94	1.00	0.94	1.00	0.94	0.94	0.94	0.94	1.00	
Adj. Flow (vph)	0	0	0	106	148	11	0	2526	181	61	2801	0	
RTOR Reduction (vph)	0	0	0	0	2	0	0	0	0	0	0	0	
Lane Group Flow (vph)	0	0	0	95	168	0	0	2526	181	61	2801	0	
Turn Type				custom	NA			NA	pm+ov	Perm	NA		
Protected Phases				3	3			2 4 9	3		6 4 9		
Permitted Phases				3					2 4 9	6 4 9			
Actuated Green, G (s)				23.6	23.6			143.9	167.5	143.9	143.9		
Effective Green, g (s)				26.6	23.6			147.9	170.5	147.9	147.9		
Actuated g/C Ratio				0.15	0.13			0.82	0.95	0.82	0.82		
Clearance Time (s)				6.0	6.0				6.0				
Vehicle Extension (s)				4.0	4.0				4.0				
Lane Grp Cap (vph)				240	221			4039	1467	61	4039		
v/s Ratio Prot				0.06	c0.10			0.51	0.02		0.57		
v/s Ratio Perm									0.10	c0.81			
v/c Ratio				0.40	0.76			0.63	0.12	1.00	0.69		
Uniform Delay, d1				69.4	75.5			5.9	0.3	16.0	6.7		
Progression Factor				1.00	1.00			1.12	1.00	0.91	0.62		
Incremental Delay, d2				1.5	15.1			0.3	0.0	86.7	0.3		
Delay (s)				70.9	90.6			6.9	0.3	101.3	4.4		
Level of Service				E	F			A	A	F	A		
Approach Delay (s)		0.0			83.5			6.4			6.5		
Approach LOS		A			F			A			A		
Intersection Summary													
HCM 2000 Control Delay			10.0		HCM 2000 Level of Service					A			
HCM 2000 Volume to Capacity ratio			0.99										
Actuated Cycle Length (s)			180.0		Sum of lost time (s)					13.5			
Intersection Capacity Utilization			67.1%		ICU Level of Service					C			
Analysis Period (min)			15										

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis

1: MD 650 & Powder Mill Rd

11/12/2018

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	71	32	109	424	36	300	141	2160	250	250	2456	43
Future Volume (vph)	71	32	109	424	36	300	141	2160	250	250	2456	43
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1800	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5	4.5	5.0	5.0	5.0	3.0	4.0		5.0	5.0	
Lane Util. Factor	0.91	0.86	0.91	0.91	0.91	1.00	1.00	0.91		1.00	0.91	
Frt	1.00	0.92	0.85	1.00	1.00	0.85	1.00	0.98		1.00	1.00	
Flt Protected	0.95	0.99	1.00	0.95	0.96	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1557	2830	1393	3113	1578	1531	1711	4585		1711	4903	
Flt Permitted	0.95	0.99	1.00	0.95	0.96	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1557	2830	1393	3113	1578	1531	1711	4585		1711	4903	
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	73	33	112	437	37	309	145	2227	258	258	2532	44
RTOR Reduction (vph)	0	0	0	0	0	265	0	7	0	0	1	0
Lane Group Flow (vph)	55	107	56	315	159	44	145	2478	0	258	2575	0
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA		Prot	NA	
Protected Phases	3	3		4	4		1	5		6	2	
Permitted Phases			3			4						
Actuated Green, G (s)	13.0	13.0	13.0	23.4	23.4	23.4	6.0	83.7		32.4	111.1	
Effective Green, g (s)	15.0	15.0	15.0	25.4	25.4	25.4	9.0	86.7		34.4	113.1	
Actuated g/C Ratio	0.08	0.08	0.08	0.14	0.14	0.14	0.05	0.48		0.19	0.63	
Clearance Time (s)	6.5	6.5	6.5	7.0	7.0	7.0	6.0	7.0		7.0	7.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	0.2		3.0	0.2	
Lane Grp Cap (vph)	129	235	116	439	222	216	85	2208		326	3080	
v/s Ratio Prot	0.04	0.04		c0.10	0.10		c0.08	c0.54		0.15	c0.53	
v/s Ratio Perm			c0.04			0.03						
v/c Ratio	0.43	0.46	0.48	0.72	0.72	0.20	1.71	1.12		0.79	0.84	
Uniform Delay, d1	78.4	78.6	78.8	73.9	73.9	68.3	85.5	46.6		69.4	26.2	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	0.79	0.60		0.95	0.89	
Incremental Delay, d2	2.3	1.4	3.1	5.5	10.5	0.5	358.2	61.1		9.6	2.2	
Delay (s)	80.7	80.0	81.9	79.4	84.3	68.8	425.7	89.3		75.3	25.5	
Level of Service	F	F	F	E	F	E	F	F		E	C	
Approach Delay (s)		80.7			76.2			107.8			30.0	
Approach LOS		F			E			F			C	
Intersection Summary												
HCM 2000 Control Delay			69.0				HCM 2000 Level of Service				E	
HCM 2000 Volume to Capacity ratio			0.97									
Actuated Cycle Length (s)			180.0				Sum of lost time (s)				18.5	
Intersection Capacity Utilization			90.6%				ICU Level of Service				E	
Analysis Period (min)			15									
c Critical Lane Group												

HCM Signalized Intersection Capacity Analysis

3: MD 650 & Elton Rd

11/12/2018

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	0	0	0	215	125	26	0	2143	345	21	2018	0
Future Volume (vph)	0	0	0	215	125	26	0	2143	345	21	2018	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)				3.0	6.0			2.5	2.0	2.5	2.5	
Lane Util. Factor				0.95	0.95			0.91	1.00	1.00	0.91	
Frt				1.00	0.98			1.00	0.85	1.00	1.00	
Flt Protected				0.95	0.99			1.00	1.00	0.95	1.00	
Satd. Flow (prot)				1625	1656			4916	1531	1711	4916	
Flt Permitted				0.95	0.99			1.00	1.00	0.06	1.00	
Satd. Flow (perm)				1625	1656			4916	1531	99	4916	
Peak-hour factor, PHF	1.00	1.00	1.00	0.94	1.00	0.94	1.00	0.94	0.94	0.94	0.94	1.00
Adj. Flow (vph)	0	0	0	229	125	28	0	2280	367	22	2147	0
RTOR Reduction (vph)	0	0	0	0	3	0	0	0	0	0	0	0
Lane Group Flow (vph)	0	0	0	190	189	0	0	2280	367	22	2147	0
Turn Type				custom	NA			NA	pm+ov	Perm	NA	
Protected Phases				3	3			2 4 9	3		6 4 9	
Permitted Phases				3					2 4 9	6 4 9		
Actuated Green, G (s)				28.8	28.8			138.7	167.5	138.7	138.7	
Effective Green, g (s)				31.8	28.8			142.7	170.5	142.7	142.7	
Actuated g/C Ratio				0.18	0.16			0.79	0.95	0.79	0.79	
Clearance Time (s)				6.0	6.0				6.0			
Vehicle Extension (s)				4.0	4.0				4.0			
Lane Grp Cap (vph)				287	264			3897	1467	78	3897	
v/s Ratio Prot				c0.12	0.11			c0.46	0.05		0.44	
v/s Ratio Perm									0.19	0.22		
v/c Ratio				0.66	0.71			0.59	0.25	0.28	0.55	
Uniform Delay, d1				69.1	71.7			7.2	0.3	5.0	6.9	
Progression Factor				1.00	1.00			0.56	1.00	0.39	0.49	
Incremental Delay, d2				6.2	9.4			0.2	0.1	1.8	0.1	
Delay (s)				75.3	81.1			4.3	0.4	3.8	3.5	
Level of Service				E	F			A	A	A	A	
Approach Delay (s)		0.0			78.2			3.7			3.5	
Approach LOS		A			E			A			A	

Intersection Summary

HCM 2000 Control Delay	9.1	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	180.0	Sum of lost time (s)	13.5
Intersection Capacity Utilization	59.8%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Arterial Level of Service
 Total AM with Improvements (15% Diverted)

11/08/2018

Arterial Level of Service: NB MD 650

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
Oakview Dr	6	48.4	468.7	0.1	8
Ramps 4&1	72	2.5	8.2	0.1	25
	114	0.8	8.1	0.1	37
	58	0.6	5.7	0.1	47
Ramp 2	66	18.4	27.1	0.1	14
Elton Rd	3	2.9	6.4	0.0	21
Ramp 8	143	5.4	12.7	0.1	17
	2	5.9	9.1	0.0	11
Powder Mill Rd	1	21.5	30.1	0.1	7
	5	9.6	65.8	0.6	34
Total		116.0	641.9	1.2	19

Arterial Level of Service: SB MD 650

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
Chalmers Rd	5	5.2	12.7	0.1	24
Powder Mill Rd	1	87.0	140.1	0.6	16
	2	7.4	12.3	0.1	15
Ramp 8	143	1.5	4.0	0.0	25
	3	5.2	9.9	0.1	21
Ramp 2	66	0.9	3.5	0.0	38
	58	3.3	13.9	0.1	27
	114	1.5	7.4	0.1	36
Ramps 4&1	72	4.3	11.3	0.1	26
Oakview Dr	6	12.9	18.8	0.1	11
Total		129.1	234.0	1.2	18

Arterial Level of Service
 Total PM with Improvements (15% Diverted)

11/09/2018

Arterial Level of Service: NB MD 650

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
Oakview Dr	7	64.1	2138.7	0.1	6
Ramps 4&1	72	2.8	8.5	0.1	24
	114	0.8	8.1	0.1	37
Ramp 2	58	0.6	5.6	0.1	47
	66	25.7	34.4	0.1	11
Elton Rd	3	2.9	6.4	0.0	20
Ramp 8	143	9.8	17.2	0.1	12
	2	9.3	12.1	0.0	8
Powder Mill Rd	1	22.1	447.3	0.1	7
	5	7.6	63.3	0.6	35
Total		145.7	2741.6	1.2	17

Arterial Level of Service: SB MD 650

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
Chalmers Rd	5	18.6	42.0	0.1	12
Powder Mill Rd	1	316.6	385.1	0.6	6
	2	7.4	12.5	0.1	16
Ramp 8	143	0.9	3.3	0.0	28
	3	4.1	8.8	0.1	24
Ramp 2	66	0.8	3.4	0.0	39
	58	1.7	12.3	0.1	31
	114	0.8	6.8	0.1	39
Ramps 4&1	72	2.1	9.0	0.1	33
Oakview Dr	7	11.2	17.1	0.1	12
Total		364.2	500.3	1.2	9

Total Network Performance By Run

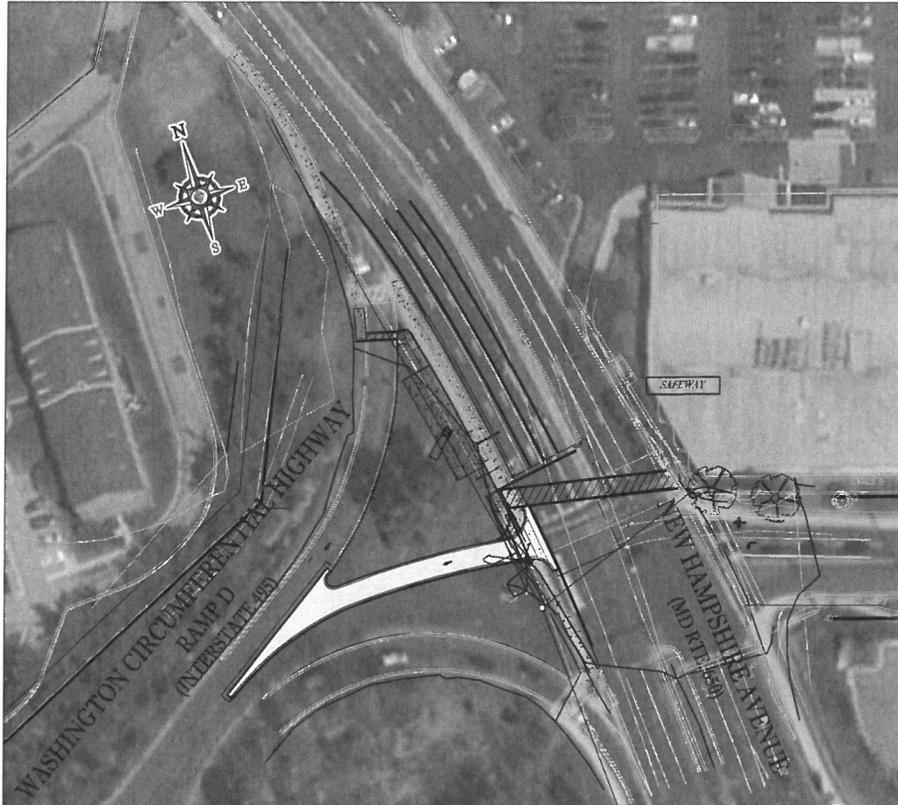
Run Number	1	2	3	4	5	Avg
Denied Delay (hr)	775.8	674.7	661.9	736.5	623.0	694.4
Denied Del/Veh (s)	253.7	224.7	219.5	242.7	208.9	230.0
Total Delay (hr)	336.5	355.3	398.5	351.7	405.1	369.4
Total Del/Veh (s)	119.0	125.6	139.7	125.3	146.0	131.1

Total Network Performance By Run

Run Number	1	2	3	4	5	Avg
Denied Delay (hr)	1334.4	1475.7	1359.4	1423.4	1312.9	1381.2
Denied Del/Veh (s)	388.1	426.7	392.5	416.7	378.1	400.4
Total Delay (hr)	561.3	544.0	501.4	422.3	542.3	514.3
Total Del/Veh (s)	192.9	187.6	172.9	147.9	185.2	177.4

Appendix C

Concept Improvement Plans



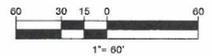
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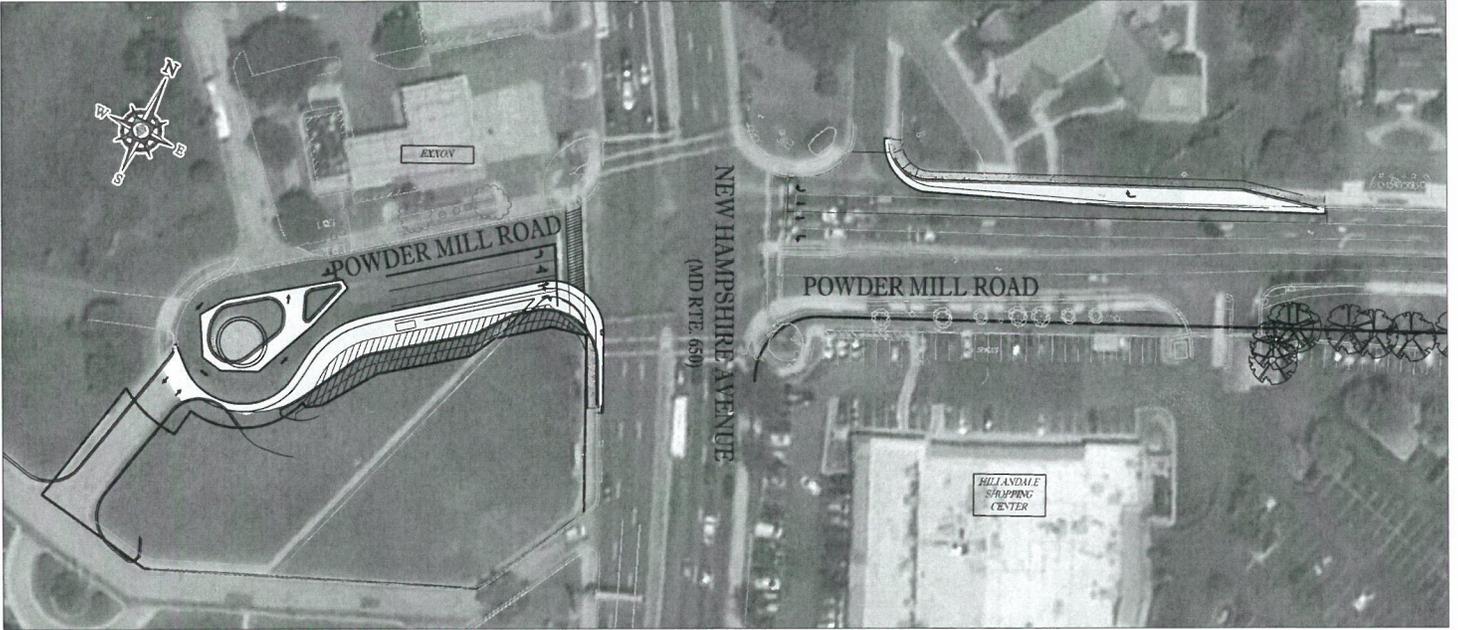
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LATIP EXHIBIT
(SLIP LANE)
DRAFT

10/22/18 | AL | EXB



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LATIP EXHIBIT
(POWDER MILL ROAD)
DRAFT

Lenhart Traffic Consulting, Inc.
Transportation Planning & Traffic Engineering

Memorandum:

Date: November 21, 2018

TO: Mr. Chris Conklin
Montgomery County DOT
101 Monroe Street, #10
Rockville, MD 20850

FROM: Mike Lenhart

RE: White Oak LATIP Supplemental Analysis – Cut-through Traffic

This memorandum is being completed in response to concerns raised about cut-through traffic as a result of the proposed slip-ramp from Elton Road to I-495 westbound. Based on the content of the testimony at the November 15, 2018 Public Hearing for this project, as well as on available traffic volume data, it appears that the primary concern associated with cut-through traffic is more about safety (with vehicles unsafely traveling at high speeds through the residential neighborhood) than about the actual volume of vehicles cutting-through the neighborhood.

To the extent the cut-through issue is related to safety and speeds, the recent series of speed humps installed by Prince George's County along Wooded Way and Elton Road, coupled with the proposed traffic calming to be installed with the slip ramp on the Montgomery County side of Elton Road should substantially decrease speeds and enhance safety. The proposed traffic calming to be installed along Elton Road in conjunction with the slip ramp includes a speed hump as well as several measures designed to narrow the roadway width and effectively reduce speeds. We believe these measures will substantially enhance safety along Elton Road (and Wooded Way) and effectively address the vast majority of safety related cut-through issues noted to date. Importantly, these measures will address vehicles traveling east or west whether they are associated with the ramp or not (i.e existing issues).

While we believe the above measures will be highly effective in providing relief related to unsafe cut-through traffic along Elton Road, should the County decide that additional measures are necessary to address the volume component of the cut-through traffic issue, the most effective options for reducing this traffic would involve implementing turn restrictions from MD 212 onto Wooded Way or converting Wooded Way to one-way. These improvements would be cost-effective and would directly address the source of the cut-through traffic.

However, given that these improvements require action from Prince George's County, which is beyond Montgomery County's control, if Montgomery County wishes to take direct action to mitigate cut-through traffic it is our recommendation that westbound traffic be prohibited along Elton Road immediately east of Avenel Garden Lane (between the predominantly commercial land uses to the west and residential neighborhood to the east). Prohibiting westbound traffic from passing this location would completely negate the potential for any neighborhood cut-through traffic associated with the ramp. Should MCDOT find it necessary, this solution would maintain the majority of the benefits of the proposed slip ramp by providing access to I-495W for travelers from the office, industrial, and shopping center uses along Elton



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Transportation Planning & Traffic Engineering

Road without requiring that they traverse the problematic and congested MD 650 & Powder Mill Road intersection which we are trying to improve (as explained in detail in the REVISED White Oak LATIP Supplemental Analysis dated November 12, 2018).

In order to understand the effects of restricting westbound traffic along Elton Road, an analysis was conducted comparing the results shown in the November 12, 2018 REVISED White Oak LATIP Supplemental Analysis (the 'November 12 memo') to results if westbound traffic were to be restricted. The analysis was completed as follows:

Three scenarios were evaluated. The first two scenarios were taken directly from the November 12 memo, while the third scenario is a new scenario showing the impacts of vehicles being diverted to the MD 650 & Powder Mill Road intersection if the westbound restriction along Elton Lane were to be implemented. The scenarios are as follows:

- Total Conditions with no improvements (No Build) to intersection geometry and timings.
- Total Conditions with the following improvements:
 1. An additional EB left-turn lane (including modifications to existing lane use) and WB right-turn lane at the intersection of MD 650 & Powder Mill Road. Note that a dedicated WB right-turn lane at the intersection of MD 650 & Powder Mill Road is present under Existing Conditions, however, the westbound right turn lane is only 50' long. This is far shorter than a typical turn lane and is completely unusable because access to the right turn lane is blocked by queues in the adjacent lanes. Therefore, this 50' lane was not treated as a right turn lane in the analysis of existing geometrics.
 2. A slip ramp at the intersection of MD 650 & Elton Road to provide direct access from Elton Road to I-495 WB.
 3. Traffic calming along Elton Road in order to reduce speeds and enhance safety.
- Total Conditions with the above improvements and the westbound restriction on Elton Road.

The following intersections were analyzed as part of this analysis including:

1. MD 650 & Powder Mill Road
2. MD 650 & Elton Road

In addition to this memo, the following exhibits and appendices have been included:

- | | |
|-----------|---|
| Exhibit 1 | Presents a location map, shows the study intersections, and notes where the proposed westbound restriction would be implemented along Elton Road. |
| Exhibit 2 | Shows the Total Peak Hour Volumes with the Slip Ramp. This exhibit is the same as Exhibit 8c in the November 12 memo. |
| Exhibit 3 | Displays the diversions that would result if westbound traffic is restricted along Elton Road. |
| Exhibit 4 | Includes the Total Peak Hour Volumes resulting from implementation of the slip ramp and the westbound restriction along Elton Road. |



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Exhibit 5 Provides a table showing Level of Service using the HCS methodology at the two study intersections for each of the three scenarios. The LATIP uses an 80 second threshold for the determination of intersection adequacy.

The following information is a summary of the results of our analyses:

- The improvements proposed as part of this project (without the westbound restriction along Elton Road) are projected to enhance operations at the intersection of MD 650 & Powder Mill by 40% during the AM peak hour and 43% during the PM peak hour compared to the No Build scenario.
- The implementation of a westbound restriction along Elton Road (and associated diverted traffic to the MD 650 & Powder Mill intersection) is slightly less beneficial to the intersection of MD 650 & Powder Mill Road than if no restriction were in place, however even so there is still a 28% benefit during the AM peak hour and 37% benefit during the PM peak hour compared to the No Build.
- All intersections will continue to operate within the 80 second LATIP delay threshold under the scenario where the improvements are implemented and a westbound restriction is implemented along Elton Road in order to reduce cut-through traffic.

We welcome the opportunity to discuss our analysis and assumptions however, based on the results of this analysis, all signalized study intersections under the "Total with Improvements and Westbound Restriction on Elton Road" scenario will operate with less than 80 seconds of delay and will satisfy LATIP requirements. If you have any questions regarding this matter, please do not hesitate to contact me at the number below. We look forward to your feedback and guidance in how you would like to proceed.

Thanks,
Mike

- Study Intersections:
1. MD 650 & Powder Mill Road
 2. MD 650 & Elton Road

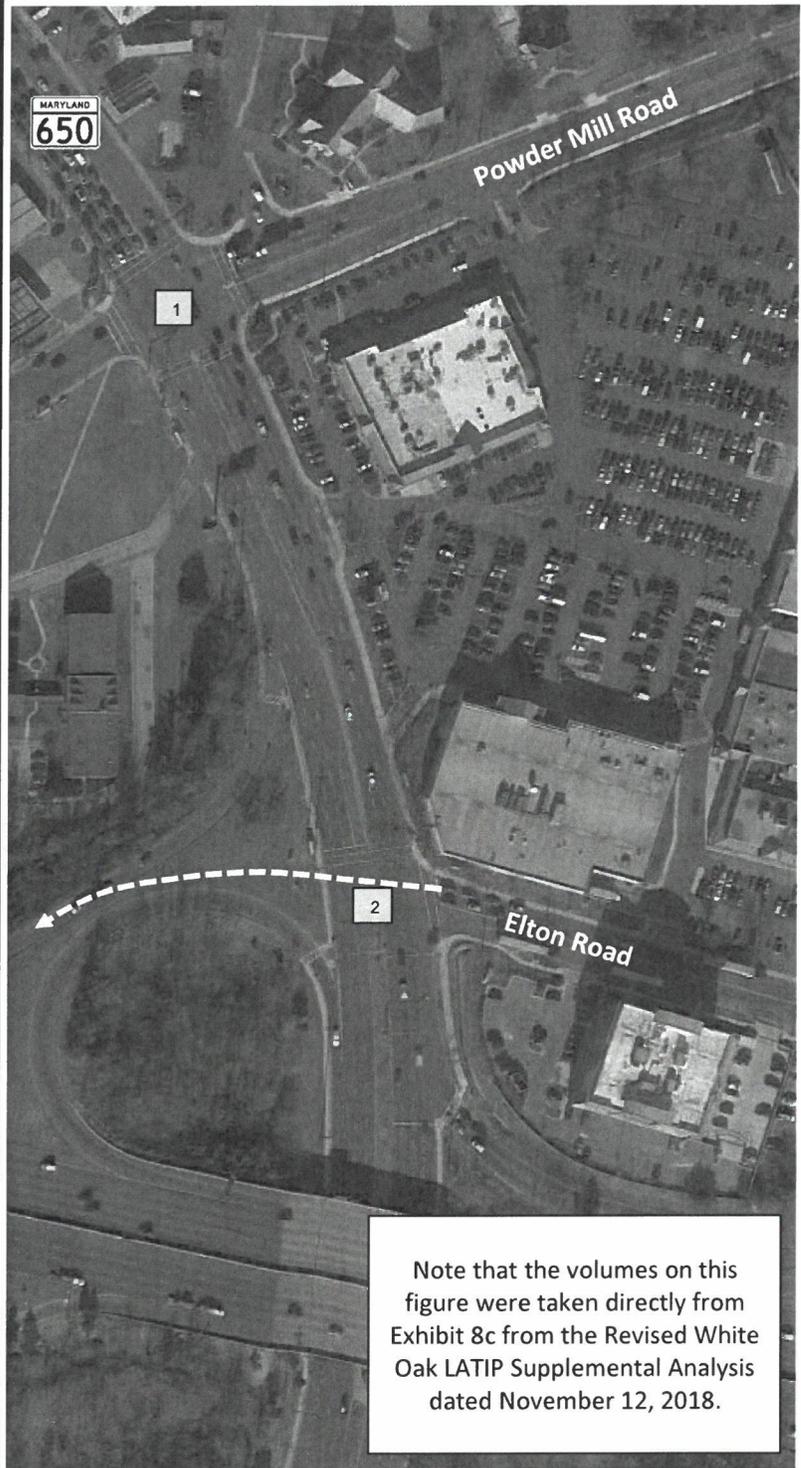
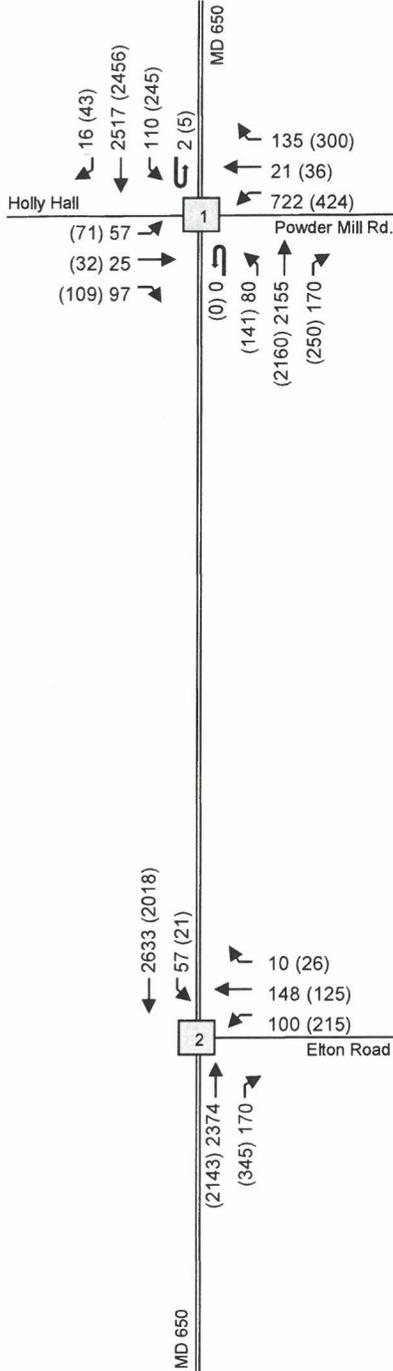


White Oak LATIP Analysis

Location
Map

Exhibit
1

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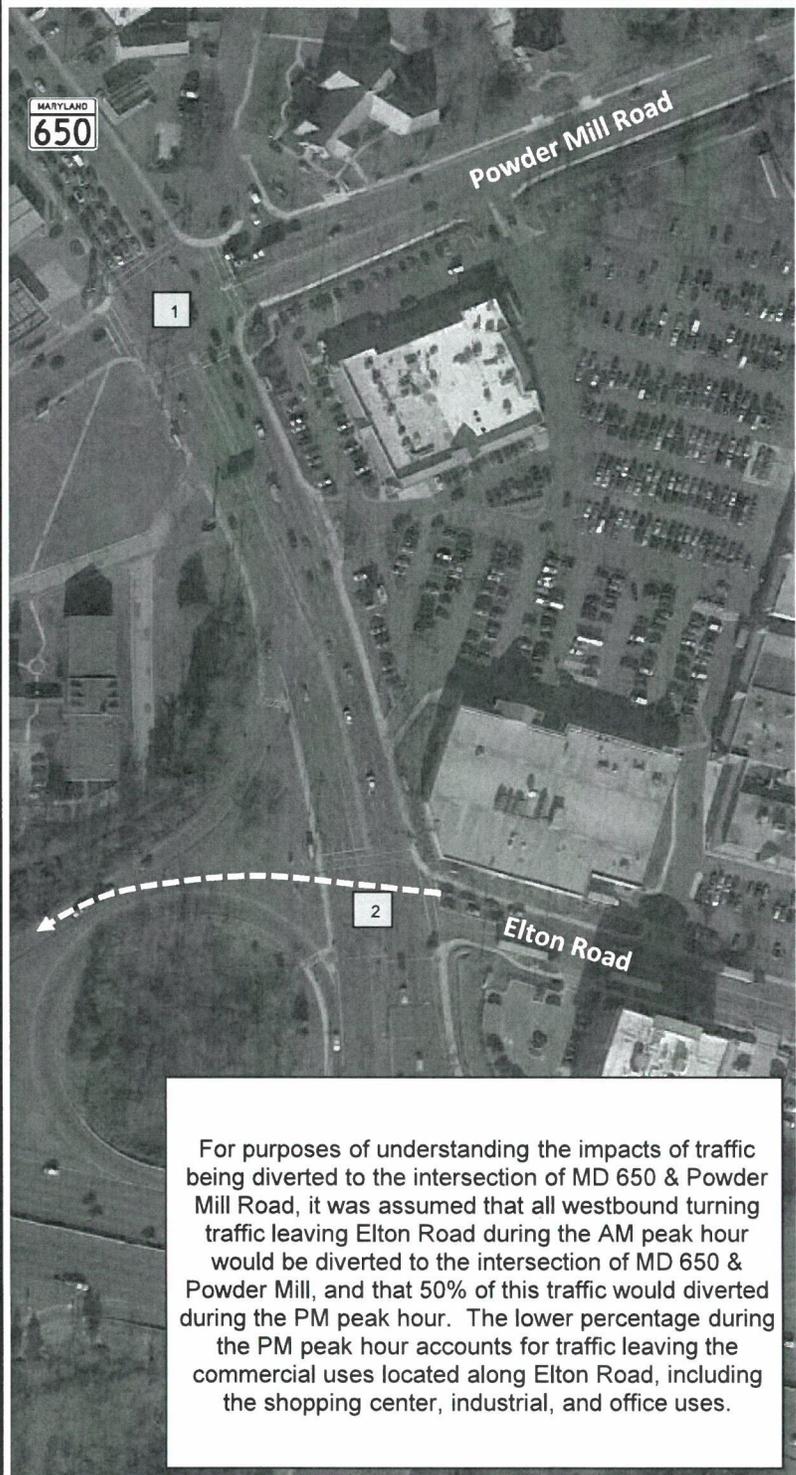
White Oak LATIP Analysis

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Total Peak Hour Volumes with Slip Ramp

Key: xx = AM Peak Vol's (xx) = PM Peak Vol's

Exhibit 2



For purposes of understanding the impacts of traffic being diverted to the intersection of MD 650 & Powder Mill Road, it was assumed that all westbound turning traffic leaving Elton Road during the AM peak hour would be diverted to the intersection of MD 650 & Powder Mill, and that 50% of this traffic would be diverted during the PM peak hour. The lower percentage during the PM peak hour accounts for traffic leaving the commercial uses located along Elton Road, including the shopping center, industrial, and office uses.

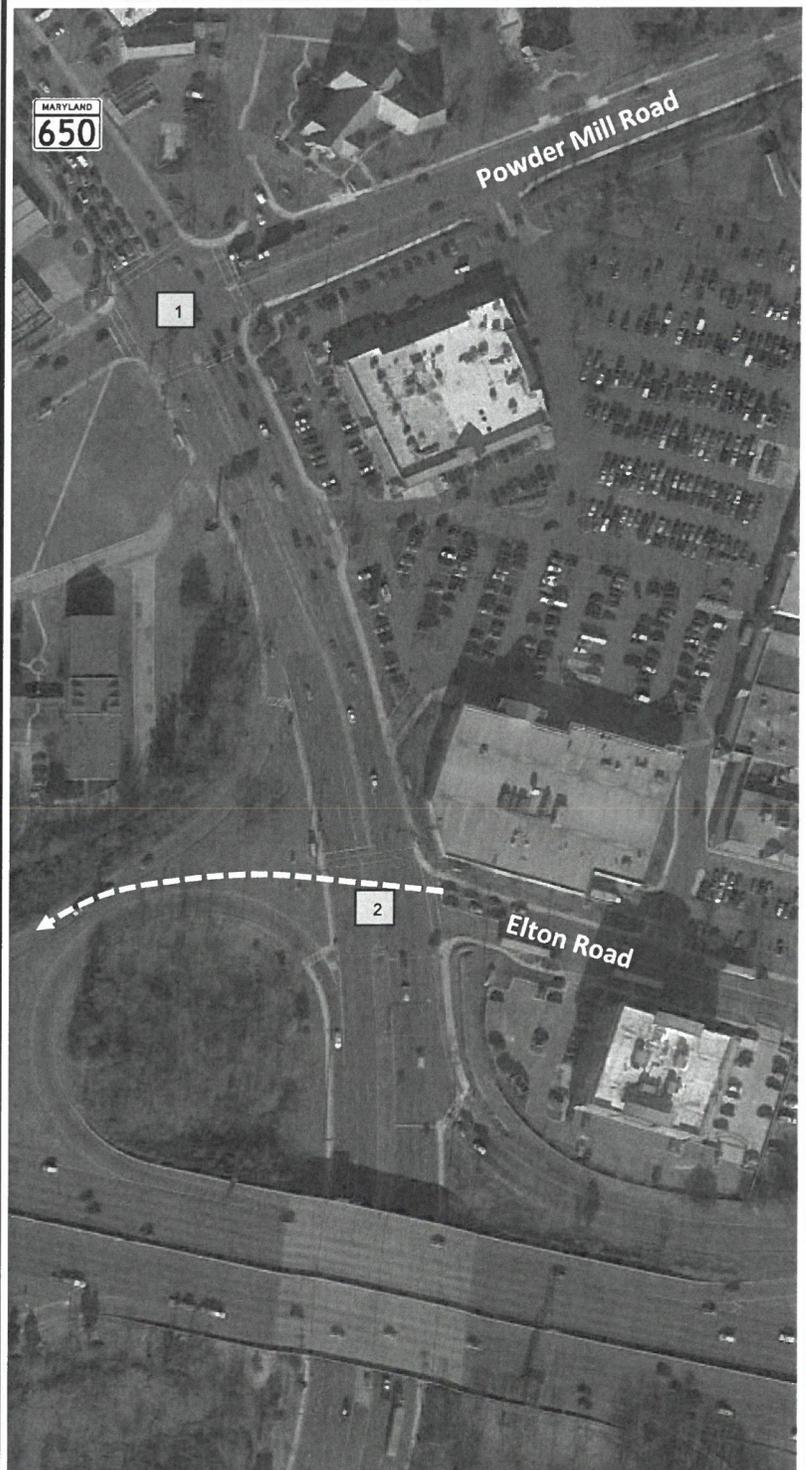
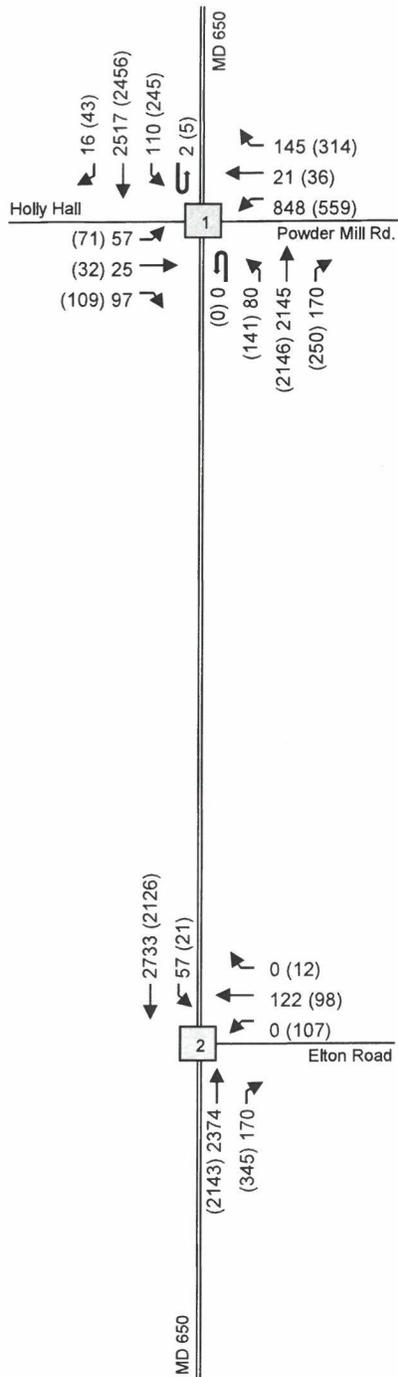
White Oak LATIP Analysis

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Diversions as a Result
 of Westbound Restriction

Key: xx = AM Peak Vol's (xx) = PM Peak Vol's

**Exhibit
 3**



White Oak LATIP Analysis

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Total Peak Hour Volumes with
Slip Ramp & WB Restriction

Key: xx = AM Peak Vol's (xx) = PM Peak Vol's

Exhibit
4

2040 Traffic Operations Results

(Level of Service / Average Delay per Vehicle in Seconds)

Morning Peak Hour	No Build	With Improvements	With Improvements and WB Restriction on Elton Road
1). MD 650 & Powder Mill Road <i>Percent Improvement compared to No Build</i>	E / 76.9 ---	D / 46.0 40%	E / 55.2 28%
2). MD 650 & Elton Road	A / 4.8	A / 10.0	A / 5.8
Evening Peak Hour	No Build	With Improvements	With Improvements and WB Restriction on Elton Road
1). MD 650 & Powder Mill Road <i>Percent Improvement compared to No Build</i>	F / 125.0 ---	E / 71.2 43%	E / 78.4 37%
2). MD 650 & Elton Road	A / 9.6	A / 9.4	A / 5.4

- Notes:
1. Results shown in the following format: Level of Service / Average Delay per Vehicle in Seconds
 2. The Average Delay per Vehicle in Seconds is the average delay experienced by each and every vehicle passing through the intersection, i.e. an average delay of 60.0 seconds indicates that it takes every vehicle, on average, one minute to get through the intersection, regardless of which direction the vehicle is traveling.
 3. All results are from Synchro/SimTraffic, a traffic analysis and microsimulation software package.

White Oak LATIP Analysis

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Results of HCS
 Level-of-Service Analyses

**Exhibit
 5**

HCM Signalized Intersection Capacity Analysis

1: MD 650 & Powder Mill Rd

AM Total AM with Improvements with 15% Left Turns Diverted & WB Restriction

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	57	25	97	848	21	145	80	2145	170	112	2517	16
Future Volume (vph)	57	25	97	848	21	145	80	2145	170	112	2517	16
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1800	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5	4.5	5.0	5.0	5.0	3.0	4.0		5.0	5.0	
Lane Util. Factor	0.91	0.86	0.91	0.91	0.91	1.00	1.00	0.91		1.00	0.91	
Frt	1.00	0.91	0.85	1.00	1.00	0.85	1.00	0.99		1.00	1.00	
Flt Protected	0.95	0.99	1.00	0.95	0.96	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1557	2814	1393	3113	1566	1531	1711	4606		1711	4911	
Flt Permitted	0.95	0.99	1.00	0.95	0.96	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1557	2814	1393	3113	1566	1531	1711	4606		1711	4911	
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	59	26	100	874	22	149	82	2211	175	115	2595	16
RTOR Reduction (vph)	0	0	0	0	0	124	0	3	0	0	0	0
Lane Group Flow (vph)	47	88	50	594	302	25	82	2383	0	115	2611	0
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA		Prot	NA	
Protected Phases	3	3		4	4		1	5		6	2	
Permitted Phases			3			4						
Actuated Green, G (s)	12.0	12.0	12.0	28.0	28.0	28.0	3.0	94.9		17.6	110.5	
Effective Green, g (s)	14.0	14.0	14.0	30.0	30.0	30.0	6.0	97.9		19.6	112.5	
Actuated g/C Ratio	0.08	0.08	0.08	0.17	0.17	0.17	0.03	0.54		0.11	0.62	
Clearance Time (s)	6.5	6.5	6.5	7.0	7.0	7.0	6.0	7.0		7.0	7.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	0.2		3.0	0.2	
Lane Grp Cap (vph)	121	218	108	518	261	255	57	2505		186	3069	
v/s Ratio Prot	0.03	0.03		0.19	c0.19		c0.05	c0.52		0.07	c0.53	
v/s Ratio Perm			c0.04			0.02						
v/c Ratio	0.39	0.40	0.46	1.15	1.16	0.10	1.44	0.95		0.62	0.85	
Uniform Delay, d1	78.9	79.0	79.4	75.0	75.0	63.5	87.0	38.8		76.6	27.0	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	0.83	0.60		0.93	0.88	
Incremental Delay, d2	2.1	1.2	3.1	86.7	104.9	0.2	261.2	8.3		4.6	2.5	
Delay (s)	81.0	80.2	82.5	161.7	179.9	63.7	333.6	31.6		75.6	26.1	
Level of Service	F	F	F	F	F	E	F	C		E	C	
Approach Delay (s)		81.1			153.0			41.6			28.2	
Approach LOS		F			F			D			C	
Intersection Summary												
HCM 2000 Control Delay	55.2			HCM 2000 Level of Service				E				
HCM 2000 Volume to Capacity ratio	0.96											
Actuated Cycle Length (s)	180.0			Sum of lost time (s)				18.5				
Intersection Capacity Utilization	88.4%			ICU Level of Service				E				
Analysis Period (min)	15											
c Critical Lane Group												

HCM Signalized Intersection Capacity Analysis

3: MD 650 & Elton Rd

AM Total AM with Improvements with 15% Left Turns Diverted & WB Restriction

														
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR		
Lane Configurations														
Traffic Volume (vph)	0	0	0	0	122	0	0	2374	170	57	2733	0		
Future Volume (vph)	0	0	0	0	122	0	0	2374	170	57	2733	0		
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900		
Total Lost time (s)					6.0			2.5	2.0	2.5	2.5			
Lane Util. Factor					0.95			0.91	1.00	1.00	0.91			
Frt					1.00			1.00	0.85	1.00	1.00			
Flt Protected					1.00			1.00	1.00	0.95	1.00			
Satd. Flow (prot)					1711			4916	1531	1711	4916			
Flt Permitted					1.00			1.00	1.00	0.04	1.00			
Satd. Flow (perm)					1711			4916	1531	79	4916			
Peak-hour factor, PHF	1.00	1.00	1.00	0.94	1.00	0.94	1.00	0.94	0.94	0.94	0.94	1.00		
Adj. Flow (vph)	0	0	0	0	122	0	0	2526	181	61	2907	0		
RTOR Reduction (vph)	0	0	0	0	0	0	0	0	0	0	0	0		
Lane Group Flow (vph)	0	0	0	0	122	0	0	2526	181	61	2907	0		
Turn Type				custom	NA			NA	pm+ov	Perm	NA			
Protected Phases				3	3			2 4 9	3		6 4 9			
Permitted Phases				3					2 4 9	6 4 9				
Actuated Green, G (s)					19.2			148.3	167.5	148.3	148.3			
Effective Green, g (s)					19.2			152.3	170.5	152.3	152.3			
Actuated g/C Ratio					0.11			0.85	0.95	0.85	0.85			
Clearance Time (s)					6.0				6.0					
Vehicle Extension (s)					4.0				4.0					
Lane Grp Cap (vph)					182			4159	1467	66	4159			
v/s Ratio Prot					c0.07			0.51	0.02		0.59			
v/s Ratio Perm									0.10	c0.77				
v/c Ratio					0.67			0.61	0.12	0.92	0.70			
Uniform Delay, d1					77.4			4.4	0.3	9.8	5.2			
Progression Factor					1.00			1.06	1.00	0.97	0.36			
Incremental Delay, d2					10.1			0.2	0.0	56.2	0.3			
Delay (s)					87.5			4.9	0.3	65.7	2.2			
Level of Service					F			A	A	E	A			
Approach Delay (s)		0.0			87.5			4.6			3.5			
Approach LOS		A			F			A			A			
Intersection Summary														
HCM 2000 Control Delay				5.8								HCM 2000 Level of Service	A	
HCM 2000 Volume to Capacity ratio				0.91										
Actuated Cycle Length (s)				180.0							13.5			
Intersection Capacity Utilization				67.6%									ICU Level of Service	C
Analysis Period (min)				15										

c Critical Lane Group

HCM Signalized Intersection Capacity Analysis

1: MD 650 & Powder Mill Rd

Total PM with Improvements with 15% Left Turns Diverted & WB Restriction

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	71	32	109	559	36	314	141	2146	250	250	2456	43
Future Volume (vph)	71	32	109	559	36	314	141	2146	250	250	2456	43
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1800	1900	1900	1900	1900
Total Lost time (s)	4.5	4.5	4.5	5.0	5.0	5.0	3.0	4.0		5.0	5.0	
Lane Util. Factor	0.91	0.86	0.91	0.91	0.91	1.00	1.00	0.91		1.00	0.91	
Frt	1.00	0.92	0.85	1.00	1.00	0.85	1.00	0.98		1.00	1.00	
Flt Protected	0.95	0.99	1.00	0.95	0.96	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (prot)	1557	2830	1393	3113	1574	1531	1711	4584		1711	4903	
Flt Permitted	0.95	0.99	1.00	0.95	0.96	1.00	0.95	1.00		0.95	1.00	
Satd. Flow (perm)	1557	2830	1393	3113	1574	1531	1711	4584		1711	4903	
Peak-hour factor, PHF	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Adj. Flow (vph)	73	33	112	576	37	324	145	2212	258	258	2532	44
RTOR Reduction (vph)	0	0	0	0	0	273	0	5	0	0	1	0
Lane Group Flow (vph)	55	107	56	409	204	51	145	2465	0	258	2575	0
Turn Type	Split	NA	Perm	Split	NA	Perm	Prot	NA		Prot	NA	
Protected Phases	3	3		4	4		1	5		6	2	
Permitted Phases			3			4						
Actuated Green, G (s)	13.0	13.0	13.0	26.1	26.1	26.1	6.0	80.1		33.3	108.4	
Effective Green, g (s)	15.0	15.0	15.0	28.1	28.1	28.1	9.0	83.1		35.3	110.4	
Actuated g/C Ratio	0.08	0.08	0.08	0.16	0.16	0.16	0.05	0.46		0.20	0.61	
Clearance Time (s)	6.5	6.5	6.5	7.0	7.0	7.0	6.0	7.0		7.0	7.0	
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	0.2		3.0	0.2	
Lane Grp Cap (vph)	129	235	116	485	245	239	85	2116		335	3007	
v/s Ratio Prot	0.04	0.04		c0.13	0.13		c0.08	c0.54		0.15	c0.53	
v/s Ratio Perm			c0.04			0.03						
v/c Ratio	0.43	0.46	0.48	0.84	0.83	0.21	1.71	1.16		0.77	0.86	
Uniform Delay, d1	78.4	78.6	78.8	73.8	73.7	66.3	85.5	48.5		68.5	28.3	
Progression Factor	1.00	1.00	1.00	1.00	1.00	1.00	0.79	0.63		0.95	0.90	
Incremental Delay, d2	2.3	1.4	3.1	12.6	20.8	0.4	358.7	79.2		8.1	2.6	
Delay (s)	80.7	80.0	81.9	86.4	94.5	66.7	426.7	109.9		72.9	28.0	
Level of Service	F	F	F	F	F	E	F	F		E	C	
Approach Delay (s)		80.7			81.4			127.4			32.1	
Approach LOS		F			F			F			C	
Intersection Summary												
HCM 2000 Control Delay			78.4				HCM 2000 Level of Service				E	
HCM 2000 Volume to Capacity ratio			1.01									
Actuated Cycle Length (s)			180.0				Sum of lost time (s)				18.5	
Intersection Capacity Utilization			92.8%				ICU Level of Service				F	
Analysis Period (min)			15									
c Critical Lane Group												

HCM Signalized Intersection Capacity Analysis

3: MD 650 & Elton Rd

Total PM with Improvements with 15% Left Turns Diverted & WB Restriction

													
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR	
Lane Configurations													
Traffic Volume (vph)	0	0	0	107	98	12	0	2143	345	21	2126	0	
Future Volume (vph)	0	0	0	107	98	12	0	2143	345	21	2126	0	
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	
Total Lost time (s)				3.0	6.0			2.5	2.0	2.5	2.5		
Lane Util. Factor				0.95	0.95			0.91	1.00	1.00	0.91		
Frt				1.00	0.98			1.00	0.85	1.00	1.00		
Flt Protected				0.95	1.00			1.00	1.00	0.95	1.00		
Satd. Flow (prot)				1625	1676			4916	1531	1711	4916		
Flt Permitted				0.95	1.00			1.00	1.00	0.06	1.00		
Satd. Flow (perm)				1625	1676			4916	1531	107	4916		
Peak-hour factor, PHF	1.00	1.00	1.00	0.94	1.00	0.94	1.00	0.94	0.94	0.94	0.94	1.00	
Adj. Flow (vph)	0	0	0	114	98	13	0	2280	367	22	2262	0	
RTOR Reduction (vph)	0	0	0	0	3	0	0	0	0	0	0	0	
Lane Group Flow (vph)	0	0	0	103	119	0	0	2280	367	22	2262	0	
Turn Type				custom	NA			NA	pm+ov	Perm	NA		
Protected Phases				3	3			2 4 9	3		6 4 9		
Permitted Phases				3					2 4 9	6 4 9			
Actuated Green, G (s)				20.7	20.7			146.8	167.5	146.8	146.8		
Effective Green, g (s)				23.7	20.7			150.8	170.5	150.8	150.8		
Actuated g/C Ratio				0.13	0.11			0.84	0.95	0.84	0.84		
Clearance Time (s)				6.0	6.0				6.0				
Vehicle Extension (s)				4.0	4.0				4.0				
Lane Grp Cap (vph)				213	192			4118	1467	89	4118		
v/s Ratio Prot				0.06	c0.07			c0.46	0.03		0.46		
v/s Ratio Perm									0.21	0.21			
v/c Ratio				0.48	0.62			0.55	0.25	0.25	0.55		
Uniform Delay, d1				72.5	75.9			4.4	0.3	3.0	4.4		
Progression Factor				1.00	1.00			0.56	1.00	0.41	0.35		
Incremental Delay, d2				2.4	6.9			0.2	0.1	1.2	0.1		
Delay (s)				74.8	82.8			2.6	0.4	2.5	1.6		
Level of Service				E	F			A	A	A	A		
Approach Delay (s)		0.0			79.2			2.3			1.7		
Approach LOS		A			E			A			A		
Intersection Summary													
HCM 2000 Control Delay			5.4		HCM 2000 Level of Service					A			
HCM 2000 Volume to Capacity ratio			0.58										
Actuated Cycle Length (s)			180.0		Sum of lost time (s)					13.5			
Intersection Capacity Utilization			55.6%		ICU Level of Service					B			
Analysis Period (min)			15										

c Critical Lane Group